KERALA TECHNOLOGICAL UNIVERSITY

(THRISSUR CLUSTER - 07)

SCHEME AND SYLLABI

of

M. TECH.

in

WATER RESOURCES AND HYDROINFORMATICS

(THRISSUR CLUSTER-07)

OFFERING DEPARTMENT

CIVIL ENGINEERING

CLUSTER LEVEL GRADUATE PROGRAM COMMITTEE

1.	Dr. Devdas Menon, Professor, IIT Madras, Chennai	Chairman
2	Principal, Government Engineering College Trichur, Thrissur	Convener
3	Principal, AXIS College of Engineering & Technology, East Kodaly, Murikkingal, Thrissur	Member
4	Principal, IES College of Engineering, Chittilapilly, Thrissur	Member
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6	Principal, Royal College of Engineering & Technology, Akkikkavu, Thrissur	Member
7	Principal, Sahrdaya College of Engineering & Technology, Kodakara, Thrissur	Member
8	Principal, Thejus Engineering College, Vellarakkad, Erumappetty, Thrissur	Member
9	Principal, Universal Engineering College, Vallivattom, Konathakunnu, Thrissur	Member
10	Principal, Vidya Academy of Science & Technology, Thalakkottukara, Thrissur	Member

CERTIFICATE

This is to certify that

1. The scheme and syllabi are prepared in accordance with the regulation and guidelines issued by the KTU from time to time and also as per the decisions made in the CGPC meetings.
2. The suggestions/modifications suggested while presenting the scheme and syllabi before CGPC on 25.6.2015 have been incorporated.
3. There is no discrepancy among the soft copy in MS word format, PDF and hard copy of the syllabi submitted to the CGPC.
4. The document has been verified by all the constituent colleges.

Coordinator in charge of syllabus revision of the programme

Prof. Reeba Thomas
Associate Professor in Civil Engineering
Government Engineering College Trichur
Thrissur-680009

Principal of the lead college

Dr. Indiradevi P.
Principal
Government Engineering College Trichur
Thrissur-680009

Principals of the colleges in which the programme is offered

No	Name of the college	Principal's Name	Signature
1	Government Engineering College Trichur	Dr. Indiradevi P.	

Date:
Place:

Chairman
CGPC

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To satisfy the requirement of water resource professionals for the implementation of imminent National Water Policy which has major objectives as "*(i) Resource planning for providing maximum availability of water; (ii) Regulate exploitation of groundwater (iii) Setting water allocation priorities in the following order: Drinking water, Irrigation, Hydropower, and other uses"*
2. To cater the need of GIS professionals in different fields of engineering, especially in the implementation of imminent National Water Policy that has another objective as: "*establishing a standardized national information system with a network of data banks and databases.*"
3. To meet the faculty requirement of the Civil Engineering Educational System with skilled personnel who have been trained with the capability in GIS based planning, as the working platform for any Civil Engineering Planning will become GIS in the near future.
4. To plug in the lacuna of engineering professionals with high-end computing and problem solving capability including both hard and soft computing, to meet the challenges of competitive global market with confidence.
5. To inculcate professional ethics and code of professional practice so that they become committed, loyal and trustworthy engineers who are capable of assessing the economic consequences of different engineering solutions for the benefits of common man
6. To foster the progressive-learning attitude and passion for knowledge so as to transform them into good researchers and hence to play a critical role in addressing global objectives for a sustainable environment.

PROGRAMME OUTCOMES (POs)

1. Apply knowledge of mathematics, science and engineering in regulating exploitation of groundwater and Setting water allocation priorities and water resources problems
2. Plan and design water resources system components/processes to meet the desired needs of the society within economic, social, environmental, ethical and sustainability constraints.
3. Develop remote sensing and GIS application tools and hence to create information system for data bank and data bases
4. Identify, collect and interpret the water resources field as well as experimental data for the simulation of various Hydrology and water resources engineering problems
5. Get professional level employment and/pursue higher degree
6. To understand, predict and quantify impacts of new projects while assessing the social economic viability
7. Gain proficiency in the usages of tools like spreadsheets, mathematical and statistical packages, GIS and remote sensing packages, Simulation models
8. Acquire confidence and research aptitude for taking up challenging problems of competing global scenario
9. Communicate effectively and professionally in written as well as in oral form
10. Work as an effective team member in group activities

SCHEME

SCHEME FOR M.TECH PROGRAMME IN WATER RESOURCES AND HYDROINFORMATICS

SEMESTER 1

Exam Slot	Course Code	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	07 MA6001	Applied Statistics	4-0-0	40	60	3	4
B	07 CE 6403	Advanced Free Surface Flow	4-0-0	40	60	3	4
C	07 CE 6405	GIS and Hydroinformatics	3-0-0	40	60	3	3
D	07 CE 6407	Surface Water Hydrology	3-0-0	40	60	3	3
E		Elective	3-0-0	40	60	3	3
	07 GN 6001	Research Methodology	0-2-0	100	0	0	2
	07 CE 6409	Hydroinformatics Lab	0-0-2	100	0	0	1
	07CE 6417	Introduction to Seminar	0-0-1	0	0	0	0
TOTAL CREDITS							20

LIST OF ELECTIVES FOR FIRST SEMESTER

07 CE 6411 Watershed Conservation and Management

07 CE 6413 Information Technology for GIS data Management

07 CE 6415 Earth and Rock fill Dams

07 CE 6113 Industrial Water Pollution Control

SEMESTER 2

Exam Slot	Course Code	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	07 CE 6402	Water Resources Systems Engineering	3-0-0	40	60	3	3
B	07 CE 6404	Advanced Groundwater Hydrology	3-0-0	40	60	3	3
C	07 CE 6406	Remote Sensing	3-0-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
	07 CE 6408	Seminar	0-2-0	100	0	0	2
	07 CE 6426	Mini Project	0-0-4	100	0	0	2
	07 CE 6412	Hydro-modelling Lab	0-0-2	100	0	0	1
TOTAL CREDITS							20

LIST OF ELECTIVES FOR SECOND SEMESTER

07 CE 6414	Water Power Engineering
07 CE 6416	Dam Rehabilitation Engineering
07 CE 6418	Fluvial Hydraulics
07 CE 6422	Groundwater Contamination and Pollution Transport
07 CE 6424	Data Acquisition in Hydroinformatics
07 CE 6114	Water Pollution Control and Stream Sanitation
07 CE 6106	Environmental Impact Assessment

SEMESTER 3

Exam Slot	Course Code	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A		Elective – IV	3-0-0	40	60	3	3
B		Elective – V	3-0-0	40	60	3	3
	07 CE 7401	Seminar	0-0-2	100	0	0	2
	07 CE 7403	Project (Phase 1)	0-0-12	50	0	0	6
TOTAL CREDITS							14

LIST OF ELECTIVES FOR THIRD SEMESTER

07 CE 7405	Groundwater Modeling and Management
07 CE 7407	Advanced Finite Element methods
07 CE 7409	Numerical Methods
07 CE 7411	Computational Fluid Dynamics
07 CE 7413	Soft Computing Techniques
07 CE 7415	Spatial Analysis in Watershed Management
07 CE 7417	Artificial Neural Networks
07 CE 7419	Irrigation System Design
07 CE 7423	Advanced Hydrologic Analysis and Design
07 CE 7111	Planning and Design of Environmental Facilities

SEMESTER 4

Exam Slot	Course Code	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
	07 CE 7404	Project (Phase-2)	0-0-21	70	30	0	12
TOTAL CREDITS							12

Syllabi & Course plan

07 MA 6001: APPLIED STATISTICS

(L-T-P : 4-0-0) CREDITS: 4 Year: 2015

Pre-requisites: Nil

Objective: To enable the students apply statistics in various areas of Environmental /Water Resources Engineering like sampling and analysis, stochastic modeling etc.

Syllabus

Probability distributions: Probability mass functions and probability density functions. Mean and variance. Binomial, Poisson, Exponential, Gamma, Uniform and Normal distribution. Regression and Correlation: Linear regression and correlation, partial and multiple correlation and regression. Population, random samples, parameter, statistic, sampling distribution of mean, variance. Central limit theorem (no proof). Point Estimators, Unbiasedness, maximum likelihood estimator, error estimates, interval estimation, confidence interval for means, difference between means and variances. Testing of Hypotheses: Hypothesis concerning one mean, two means, paired t-test, proportions, one variance, two variances, two observed correlation Coefficients-Fishers' Z-transformation. Fitting of distributions, Chi-square test of goodness of fit. Applications: Analysis of variance. Completely randomized designs and randomized block designs. Latin squares. Factorial experiments. Time Series Models: Components of time series, moving average method.

Course Outcomes

- *Apply the basic knowledge of the probabilistic distribution function to the field of engineering*
- *Develop the regression equation for various phenomenon under consideration*
- *Design and Testing of hypothesis*
- *Distinguish different time series models*

References:

1. Gupta.S.C. and Kapoor.V.K, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 1978.
2. Benjamin, J.R. and Cornell.C, A., 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. Kitab Mahal.1976.

Internal continuous assessment: 40 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.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 MA 6001: APPLIED STATISTICS **(L-T-P : 4-0-0) CREDITS:4**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Probability distributions: Probability mass functions and probability density functions. Mean and variance. Binomial Poisson, Exponential, Gamma, Uniform and normal distribution.	**9**	**15**
MODULE 2 Regression and correlation: Linear regression and correlation, partial and multiple correlation and regression.	**8**	**15**
FIRST INTERNAL TEST		
MODULE 3 Population, random samples, parameter, statistic, sampling distribution of mean, variance. Central limit theorem (no proof)	**8**	**15**
MODULE 4 Point Estimators, Unbiasedness, maximum likelihood estimator, error estimates, interval estimation, confidence interval for means, difference between means and variances.	**9**	**15**
SECOND INTERNAL TEST		
MODULE 5 Testing of Hypotheses: Hypothesis concerning one mean, two means, paired t-test, proportions, one variance, two variances, two observed correlation Coefficients-Fishers' Z-transformation. Fitting of distributio Chi-square test of goodness of fit.	**11**	**20**
MODULE 6 Applications: Analysis of variance. Completely randomized designs an randomized block designs. Latin squares. Factorial experiments. Time Series Models: Components of time series, moving average meth	**11**	**20**

07 CE 6403: ADVANCED FREE SURFACE FLOW

(L-T-P : 4-0-0) CREDITS: 4 Year: 2015

Prerequisite: Nil

Objective:

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

Syllabus

Classification of free surface flow. Energy and momentum equation-Channel transitions- uniform flow and critical flow computation- method of determining manning's n for natural channel-both theoretical and practical. Dynamic equation - Classification and analysis of flow profiles - computation methods for Prismatic and non-prismatic channels. Flow over Spillways - Hydraulic jump. Spatially varied steady flow. Classification of water waves. Continuity and momentum equation for one dimensional unsteady flow- general accurate and approximate methods of solution. Classification of routing models - kinematic, diffusion and dynamic waves. Overland flows–– Kinematic wave solutions for simple watershed geometry. Hydraulic flood routing through a stream- Numerical solutions - MOC. 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.

Course Outcomes:

- *Apply energy and momentum equation in simple free surface flow problems*
- *Compute flow profiles in channel transitions and due to hydraulic structures*
- *Formulate and solve the problem of propagation of flood wave and surges in channels*
- *Formulate and solve hydraulic flood routing models*

Reference

1. Chow V. T., Open channel Hydraulics, McGraw Hill book co., Inc.
2. Chaudhry, H. Open Channel Hydraulics. Springer Science & Business Media.
3. Henderson F. M., Open channel flow, McMillan Publishing Co., New York..
4. Richard H. H., French, Open channel Hydraulics, McMillan Publishing Co., New York.
5. Mahmood and Yejevich, Unsteady flow in open channels Vol.I & II, Water Resources Publication, Colorado.
6. Subramaniya K., Open channel Flow, Tata McGraw Hill Publishing Co.
7. Chow, V.T., D.R. Maidment and L.W. Mays, *Applied Hydrology*, McGraw Hill Book Company, Singapore.

Internal continuous assessment: 40 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.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 6403: ADVANCED FREE SURFACE FLOW (L-T-P : 4-0-0) CREDITS:4		
Modules	**Contact Hours**	**Sem. Exam Marks %**
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.	**9**	**15**
MODULE 2 Boundary layer and its computation-velocity distribution in turbulent flow- method of determining manning's n for natural channel-both theoretical and practical. 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.	**10**	**15**
FIRST INTERNAL TEST		
MODULE 3 Flow over Spillways - Hydraulic jump - Conditions and control of jump - Jump on sloping floor - Analysis - Applications. Spatially varied steady flow-principles and assumptions-Dynamic equation for spatially varied flow - Methods to compute flow profiles - Applications.	**9**	**15**
MODULE 4 Classification of water waves- Celerity, attenuation and amplification of waves. Continuity and momentum equation for one dimensional unsteady flow –Modification of these equations for two dimensions and non-prismatic channels. Problems involving unsteady flow in open channels- general accurate and approximate methods of solution. Classification of routing models - kinematic, diffusion and dynamic waves.	**10**	**15**
SECOND INTERNAL TEST		
MODULE 5 Overland flows- Equations of spatially varied unsteady (2D) flow over a plane –Kinematic wave solutions for simple watershed geometry. Hydraulic flood routing through a stream-Numerical solutions-MOC – significance of characteristics-iterative procedure of solution- Incorporatic of boundary conditions.	**9**	**20**
MODULE 6 FDM in fixed grid -explicit and implicit methods, McCormack scheme-CFC-stability criteria- Incorporation of boundary conditions. Preissmann Implicit Scheme- Double sweep solution.	**9**	**20**

07 CE 6405 GIS AND HYDROINFORMATICS

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Prerequisites : Nil

Course Objectives:

- *To provide a comprehensive treatise on the Geographic Information System and Hydroinformatics*
- *To equip the student for the spatial analysis of hydrologic information/system*

Syllabus

Introduction to GIS -Map and Map scales- Spatial Database Management Systems- Georeferencing. Data input-Existing GIS data-conversion of existing data. Creating new data-Spatial data editing. Data display and Data exploration. Analysis of Vector data and Raster data. Terrain mapping and analysis- Viewshed and watersheds analysis. Introduction to spatial analysis- Interpolation. GIS models and Modelling. Application of GIS to various fields of Water Resources Engineering

Course Outcomes:

- *Georeference an image and create a database from hard copy maps*
- *Apply different vector and raster analyses methods for decision making*
- *Analyse the watershed and viewsheds using GIS*
- *Plan and develop spatial information for water supply and irrigation system design*
- *Apply spatial surface water and groundwater hydrology models*

Text Books

1. *Chang, K. Introduction to Geographic Information Systems, Tata McGraw Hills Edition, New Delhi.*
2. *Agarwal, C. S., and Garg, P. K., Textbook on Remote Sensing in Natural Resources Monitoring and Management, Wheeler Publishing , Allahabad.*

References:

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

2. Praveenkumar, Alameda J, Bajcsy. P, Hydroinformatics, Taylor & Francis.
3. Maidment D. R., Arc Hydro, GIS for Water resources, ESRI Press.
4. Han J, Camber M.; Data Mining: Concepts and techniques, Morgan Kaufmann, San Francisco.
5. Davis B E. *GIS: A Visual Approach* , Onword Press, Canada.
6. *Reddy A. M Remote Sensing and Geographic Information Systems,* B S Publications, Hyderabad.
7. Lillesand, T. M., and Keifer, R. W., Remote Sensing and Image Interpretation, John Wiley & Sons, N York.
8. Meijerink M. J., De Brouwer, H.A.M., Mannaerts, C. M., and Velenzuela, C. R., Introduction to the Use of Geographical Information Systems for Practical Hydrology, ITC publication no. 23, UNESCO, Paris.

Internal continuous assessment: 40 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.

iii) Two internal tests, each having 15 marks

iv) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6405 GIS AND HYDROINFORMATICS(L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Introduction to GIS -History of GIS -Early developments in GIS - Applications of GIS. **Map and Map Scales-** Introduction to Maps-History of Maps-Map Scales Types of Maps. Map and Globe - Understanding Earth Coordinate System -Map Projection	**7**	**15**
MODULE 2 S**patial Database Management Systems-**Introduction-Data Storage-Database Structure Models Database Management system-Entity Relationship Model-Normalization-. GIS Data Model-Vector Data Structure-Raster Data structure -Geodatabase and metadata	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Vector data analysis- Buffering-overlay-distance measurement-pattern analysis. Raster data analysis-Local operations – Neighbourhood operations-zonal operations-Other raster data operations. Terrain mapping and analysis-Terrain mapping- TIN contouring –slope and aspect-Raster vs TIN	**7**	**15**
MODULE 4 Data input-Existing GIS data-conversion of existing data-Creating new data-Spatial data editing –location errors-topological errors-topological editing –non topological editing—other editing operations. Data display and cartography- symbolization- map design. Data exploration- attribute data query-spatial data query-raster data query- Graphic visualisation	**7**	**15**
SECOND INTERNAL TEST		

MODULE 5 Viewshed and watersheds- Viewshed analysis- application for view s analysis- Watershed analysis -Factors influencing watershed analy applications. Introduction to spatial analysis-Interpolation -global and l methods-IDW and kriging. GIS model and Modelling-binary moc Index models- Regression models and process models	**7**	**20**
MODULE 6 **Case studies:** Application of GIS **Suggested topics for case study:** Spatial techniques for Surface water Hydrology Modelling, Surface-Water Hydrology Models, Arc SWAT/MWSWAT model and its applications; Ground water Models and spatial techniques for Groundwater Modelling and Visualization, The Arc Hydro Data Model. Geospatial techniques for planning and design of Water-Supply and Irrigation Systems, Spatial Database Development for Wastewater and Storm water Systems, Geospatial technologies for Water Resources Monitoring and Forecasting (A group of 3 or 4 students will take up a problem in any one of the above topics and present this case study)	**7**	**20**

07 CE 6407: SURFACE WATER HYDROLOGY

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-requisites: Nil

Objective:

To comprehend the basic concepts of the water cycle and hydrology to get a conceptual and quantitative understanding of hydrology to perform engineering hydrology computations

Syllabus

Fundamental hydrology. Hydrological cycle. Introduction, Components. Catchment description. Introduction to hydrologic models. Precipitation: Characteristics, collection and presentation of rainfall data, Test for consistency and continuity of data, average precipitation depth-area-duration analysis. Hydrologic abstractions: Interception and depression storage, evaporation. Infiltration-process, Infiltration indices. Components of runoff, factors affecting runoff, Hydrograph and its components: Base flow and its separation, Unit hydrograph theory and its application. Synthetic unit hydrograph, conceptual models. Hydrometry .Computation of peak flow. Flood routing. Statistical analyses of hydrologic data - frequency analysis, probability distribution. . Recurrence interval, I-D-F curve, flow duration curve, flow mass curve. Probability distribution functions, extreme value distribution, Gumbel's, Pearson Type –III, Stochastic processes, time series analysis, synthetic data generation.

Course Outcome:

At the end of the course student will be able to

- *Analyze components of hydrologic cycle*
- *Predict hydrologic extreme events for hydraulic and hydrologic design*
- *Apply stochastic methods in solving hydrologic problems*
- *Assess surface water resources*

Text Books:

1. Subramanya, K, "Engineering Hydrology", Tata McGraw Hill
2. Chow, V.T., Maidment, D.R., Mays, L.W., Applied Hydrology, McGraw Hill
3. Jayarami Reddi, P, A Text Book of Engineering Hydrology, Laxmi Publications

References:

1. Linsley, Kohler & Paulhus, Engineering Hydrology, McGraw Hill.
2. Mays, L.W., Water Resources Engineering, John Willey and Sons, US, 2001.
3. Haan, C. T., Statistical Methods in Hydrology, Iowa State University Press, 1977.
4. Alfredo H-S. Ang, Wilson H. Tang Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering

Internal continuous assessment: 40 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.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

Modules	Contact Hours	Sem. Exam Marks %
MODULE 1 **Fundamental Hydrology**-Hydrological cycle- components of hydrologic cycle. Catchment – description- stream patterns. Introduction to hydrologic models.	**2**	**15**
Precipitation- forms, measurement, analysis of data, consistency, supplementing missing data, hyetograph, analysis, raingauge network, mean rainfall, DAD curves	**4**	
MODULE 2 **Hydrologic Abstractions**: Interception and depression storage, evaporation- factors influencing .Evapotranspiration.	**1**	**15**
Infiltration- process, measurement of infiltration, infiltration models, infiltration indices	**4**	
Runoff: - factors affecting Runoff, components of runoff, basin yield	**1**	
FIRST INTERNAL TEST		
MODULE 3 Hydrograph and its components: Base flow and its separation, Unit hydrograph theory and its application for isolated and complex storms, S-curve, Unit hydrograph of varied durations. Applications	**7**	**15**

MODULE 4 Synthetic unit hydrograph- Snyder method, CWC method, Instantaneous unit hydrograph, conceptual models. Computation of peak flow: - Rational and Empirical relationships. Design flood, design storm, PMP, PMF. Dam safety. Flood rules. - CWC guide line	**4** **2** **2**	**15**
SECOND INTERNAL TEST		
MODULE 5 Hydrometry: Gauge and discharge sites, velocity measurement, area-velocity method, stage-discharge relation, rating curve. Flood routing: Routing through reservoirs and channels .Muskingum Method, Pul's Method	**3** **4**	**20**
MODULE 6 Statistical analyses of hydrologic data - frequency analysis, probability distribution and its application to rainfall and discharge data. Recurrence interval, I-D-F curve, flow duration curve, flow mass curve	**4**	**20**
Probability distribution functions, extreme value distribution, Gumbel, Pearson Type –III, Stochastic processes, time series analysis, synthetic data generation	**4**	

07 CE 6411: WATERSHED CONSERVATION AND MANAGEMENT

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-requisites: Nil

Objective:

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

Syllabus:

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

Course Outcomes:

- *Plan and design soil conservation measures in a watershed*
- *Plan and design water harvesting and groundwater recharge structures*
- *Use watershed models for planning and management of watersheds*

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: 40 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.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6411: WATERSHED CONSERVATION AND MANAGEMENT **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam marks %**
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	**7**	**15**
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	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 **Water Harvesting Techniques** – Design of Small Water Harvesting Structures – Types of Storage Structures – Yield from a Catchment – Losses of Stored Water. Water conservation practices – manuals and guidelines	**7**	**15**
MODULE 4 **Watershed Management:** Strategies – Identification of Problems – Watershed Development Plan – Entry Point Activities — Concept of Priority Watersheds – Agro forestry – Grassland Management – Wasteland Management	**7**	**15**
SECOND INTERNAL TEST		

MODULE 5 **Government Initiative**: Watershed Approach in Government Programmes –Developing Collaborative know-how – People's Participation – Evaluation of Watershed Management.	**7**	**20**
MODULE 6 **Watershed Assessment Models:** Regulation and Restoration – A Brief Description and Significance of Watershed Models: SWAT, TMDL, AGNPS, BASINS, CREAMS – Case Studies	**7**	**20**

07 CE 6413: INFORMATION TECHNOLOGY FOR GIS DATA MANAGEMENT

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-requisites: Nil

Objectives:

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

Syllabus:

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. **File Organisation and Normalisation:** File Organisation-Sequential, Indexed Sequential, Random, Multi key file Organisation- advantages and disadvantages. Relational Database Management System- Relational Algebra – Normalisation up to BCNF – Basic SQL commands - case study for normalization using a Geographic data. **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. **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. HTML-different tags, sections image & pictures, listings, tables, frame, frameset, form. - Example pages- Dynamic Web Pages - The need of dynamic web pages.

Course Outcomes:

- Select an appropriate normalisation and Design a database for spatial information
- Manage network security and firewall
- Comprehend different web management protocols

References:

1. Elmasri & Navathe, *Fundamentals of Database Systems*, Pearson Education, fourth edition.
2. Keiser, G.E., Local area networks, Tata Mc Grawhill
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 Featuringthe Internet*, Pearson Education
5. Behrouz A Forouzan, Data Communications and Networking (SIE), Tata McGraw Hill.
6. Kenneth C. Laudon, Carol Guercio Traver, *E-Commerce-Business, Technology, Society,* Pearson Education.
7. Willian Stallings, Cryptography and Network Security, Fifth Edition, Pearson Education.
8. Bipin C. Desai, An Introduction to Database Systems,Galgotia Publications PVTLTD First edit1993

9. Ramakrishnan R. &Gehrke J., *Database Management Systems*, McGraw Hill
10. O'neil P. & O'neilE., *Database Principles, Programming, and Performance*, Harcourt Asia,Morgan Kaufman
11. Silberschatz A, Korth H.F., & Sudarshan S., *Database System Concepts*, Tata McGraw Hill
12. UllmanJ.D, *Principles of Database Systems*, Galgotia Publications
13. Nalin K. Sharda, *Multimedia Information Networking*, Prentice Hall of India.
14. Douglas E. Comer, *Computer Networks and Internets with Internet Applications*, Pearson Education
15. Stallings, *Computer Networking with Internet Protocols*, Pearson Education Asia.
16. Goncalves M, *Firewalls: A Complete Guide*, Tata McGraw Hill.
17. Kalakota R. &WhinstonA.B, *Frontiers of Electronic Commerce*, Addison Wesley.
18. Schneider G.P. &Perry J.T, *Electronic Commerce, Course Technology,* McGraw Hill, NewDelhi,2003.

Internal continuous assessment: 40 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.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

07 CE 6413 INFORMATION TECHNOLOGY FOR GIS DATA MANAGEMENT (L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem Exam Marks %**
MODULE 1 **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.	6	15%
MODULE 2 **File Organisation and Normalisation:** File Organisation-Sequential, Indexed Sequential, Random, Multi key file Organisation- advantages and disadvantages	7	15%
FIRST INTERNAL TEST		
MODULE 3 Relational Database Management System- Relational Algebra – Normalisation up to BCNF – Basic SQL commands - case study for normalization using a Geographic data.	8	15%
MODULE 4 **Fundamentals of computer networks:** Computer networks-network layers-data communication concepts-Land topology and transmission media–	7	15%

network security–OSI reference model. Network Security- Principles of Cryptography, Authentication, Integrity, Key Distribution and Certification Access Control: Firewalls, Attacks and Countermeasures		
SECOND INTERNAL TEST		
MODULE 5 **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	7	20%
MODULE 6 HTML-different tags, sections image & pictures, listings, tables, frame, frameset, form. - Example pages- Dynamic Web Pages - The need of dynamic web pages.	7	20%

07 CE 6415: EARTH AND ROCKFILL DAMS

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-requisites: Nil

Objective:

Course Objectives:

- *To introduce the basic considerations in proper selection of site, design and construction of earth and rock fill dams.*
- *To impart knowledge in stability analysis, seepage problems and foundation treatments of earth and rock fill dams*

Syllabus

Classification of dams, basic design requirements and preliminary dam sections. Analysis of seepage through dam sections-fundamentals of flow nets, seepage. Seepage control methods-impervious and drainage blankets, cut-off walls and loading berms. Stability analysis of earth fills- method of slices, Bishops method, Morgenster- price method, Jambu method. Foundation treatments of pervious and impervious rocks. Design and construction of earth and rock fill dams.

Course Outcomes:

- *Design and construction of earth and rock-Fill dams based on existing site conditions*
- *Analyze seepage problems and stability of earthen embankment dams and adopt appropriate measures of control.*
- *Identify the requirements of foundation treatment and establish proper treatment method as per field requirement.*

References

1. H.D. Sharma – Embankment Dams- Oxford and IBH Publishing Co., 1991
2. Bharath Singh and Varshney, R.S, "Engineering for Embankment Dams" A A Balkema Pub., 1995

Internal continuous assessment: 40 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.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6415 EARTH AND ROCKFILL DAMS (L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Introduction: Classification of dams- Factors considered for selection of site for dams-Basic design requirements-Typical sections of earth and rock fill dams. Construction of earth dams: construction equipment, procedures for pervious, semi-pervious, impervious and rock fill sections, construction supervision.	**7**	**15**
MODULE 2 Stability analysis of earth embankments: critical slip surfaces, test conditions, strength parameters, pore pressures, stability analysis-method of slices, Bishops method, Morgenster- price method, Jambu method.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Stability analysis of earth embankments: critical slip surfaces, test conditions, strength parameters, pore pressures, stability analysis-method of slices, Bishops method, Morgenster- price method, Jambu method.	**7**	**15**
MODULE 4 Foundation treatment: Ground investigation, assessment of suitability of foundation, treatment methods for pervious, impervious foundations and rock foundations- core contact treatment, grouting-materials and methods, foundation excavation.	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Analysis of flow through earth dams - fundamentals of seepage flow, flow nets, seepage through dam section and foundation, seepage control filters, impervious core, drainage. Control of seepage through foundations: types of foundations trench cutoff, upstream impervious blanket, horizontal drainage blanket, relief wells, drainage trenches, cut-off walls, downstream loading berm**.**	**7**	**20**
MODULE 6 Rock fill dams: Types of dams, general characteristics, materials of construction, foundation requirements, construction, analysis of deformations Design of rock fill dams: design of dam section, concrete face and earth core, Nature of failures and damages, case studies	**7**	**20**

07 CE 6113 INDUSTRIAL WATER POLLUTION CONTROL

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-Requisites: Knowledge about the treatment of wastewater

Course Objectives:

- To provide information regarding different elements of industrial water pollution and methods of treatment.
- Also to expose students to the various industrial processes and the origin, characteristics..

Syllabus

Damages caused by industrial pollution- Effects of industrial waste on stream- sewage treatment plants- Study of some typical problem caused by industrial pollution in India. Volume reduction of industrial waste- strength reduction of industrial waste- Treatment using advanced technologies like MBR, MBBR, FBR.Joint treatment of raw industrial waste with domestic sewage- Discharge of treated waste to municipal sewers- Stream protection measures. Industrial manufacturing process, characteristics of waste, waste management and treatment methods of the following industries Dairy plant, Canneries, Distilleries, Fishing industry and Sugar mills, Textile mills, Tanneries, Pulp and paper mills, Rubber industry and Metal plating industry, Oil refineries, Petrochemicals , Fertilizer plant, steam power plant-management and disposal of radioactive wastes.

Course Outcomes:

- Various treatment methods and preventive aspects of pollution of chemical process industries which release emissions, wastewater, solid residue and effluent, leading to degradation of the environment can be assessed in a broad overview.
- Indiscriminate and unregulated exploitations of both renewable and non renewable resources can be avoided.
- Increase awareness regarding imperative need for proper treatment Systems to control pollution.

References

1. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering. Addison- Wesley Pub.Co.
2. Charles .Fred. Gurnham –Principles of Industrial Waste Engineering., Wiley publishers
3. M.N. Rao and Dutta – WasteWater Treatment, Oxford-IBH Publishers.
4. Berne F. – Industrial Water Treatment, gulf Publishing Company.

Internal continuous assessment: 40 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.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 6113 INDUSTRIAL WATER POLLUTION CONTROL (L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Damages caused by industrial pollution- Effects of industrial waste on stream- Effects of industrial waste on sewage treatment plants- Study of some typical problem caused by industrial pollution in India	**7**	**15**
MODULE 2 Need for environment impact assessment for major industries. Volume reduction of industrial waste- strength reduction of industrial waste- neutralization- equalization and proportioning	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Joint treatment of raw industrial waste with domestic sewage- Joint treatment of partially treated industrial waste with domestic sewage – Discharge of treated waste to municipal sewers- Stream protection measures.	**7**	**15**
MODULE 4 Industrial manufacturing process, characteristics of waste, waste management and treatment methods of the following industries Dairy plant, Canneries, Distilleries, Fishing industry and Sugar mills.	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Industrial manufacturing process, characteristics of waste, waste management and treatment methods of the following industries Textile mills, Tanneries, Pulp and paper mills, Rubber industry and Metal plating industry	**7**	**20**
MODULE 6 Industrial manufacturing process, characteristics of waste, waste management and treatment methods of the following industries Oil refineries, Petrochemicals, Fertilizer plant, steam power plant-managem and disposal of radioactive wastes.	**7**	**20**

07 GN 6001 RESEARCH METHODOLOGY

(L-T-P : 0-2-0) CREDITS: 2 Year: 2015

Prerequisites: Nil

Course Objectives

The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses:

- The scientific research process and the various steps involved
- Formulation of research problem and research design
- Thesis preparation and presentation.
- Research proposals, publications and ethics
- Important research methods in engineering

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self study and group discussions. The faculty mainly performs a facilitator's role.

Syllabus

Overview of research methodology - Research process, scientific method, research design process.
Research Problem and Design - Formulation of research task, literature review, web as a source, problem solving approaches, experimental research, and ex post facto research.
Thesis writing, reporting and presentation -Interpretation and report writing, principles of thesis writing- format of reporting, oral presentation.
Research proposals, publications and ethics - Research proposals, research paper writing, considerations in publishing, citation, plagiarism and intellectual property rights.
Research methods – Modelling and Simulation, mathematical modeling, graphs, heuristic optimization, simulation modeling, measurement design, validity, reliability, scaling, sample design, data collection methods and data analysis

Course Outcome

At the end of course, the student will be able to:

- Discuss research methodology concepts, research problems, research designs, thesis preparations, publications and research methods.
- Analyze and evaluate research works and to formulate a research problem to pursue research
- Prepare a thesis or a technical paper, and present or publish them
- Apply the various research methods followed in engineering research for formulation and design of own research problems and to utilize them in their research project.

References:

- C. R. Kothari, Research Methodology, Methods and Techniques, New Age International Publishers

- K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan, Management Research Methodology, Integration of principles, Methods and Techniques, Pearson Education
- R. Panneerselvam, Research Methodology, PHI Learning
- Deepak Chawla, Meena Sondhi, Research Methodology–concepts & cases, Vikas Publg House
- J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
- Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
- Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.
- Fred M Kerlinger , Research Methodology
- Ranjit Kumar, Research Methodology – A step by step guide for beginners, Pearson Education
- John W Best, James V Kahan – Research in Education , PHI Learning
- Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co Ltd
- Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes
- Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
- Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
- Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
- Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
- Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047- 0,2006
- Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers..
- Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing
- Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
- Additional suitable web resources
- Guidelines related to conference and journal publications

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests and assignments. There are three tests for the course (3 x 20 = 60 marks) and assignments (40 marks). The assignments can be in the form of seminar, group tasks, case studies, research work or in a suitable format as decided by the teacher. The assessment details are to be announced to students at the beginning of the semester by the teacher.

07 GN 6001 RESEARCH METHODOLOGY (L-T-P : 0-2-0) CREDITS:2		
Modules	**Contact Hours**	**Internal Marks %**
MODULE 1 **Overview of Research Methodology** Research concepts – meaning – objectives – motivation - types of research – research process – criteria for good research – problems encountered by Indian researchers - scientific method - research design process – decisional research	5	10%
MODULE 2 **Research Problem and Design** Formulation of research task – literature review – methods – primary and secondary sources – web as a source – browsing tools -formulation of research problems – exploration - hypothesis generation - problem solving approaches-introduction to TRIZ(TIPS)- experimental research – principles - Laboratory experiment - experimental designs - ex post facto research - qualitative research	5	10%
FIRST INTERNAL TEST		
MODULE 3 **Thesis writing, reporting and presentation** Interpretation and report writing – techniques of interpretation – precautions in interpretation – significance of report writing – principles of thesis writing-format of reporting - different steps in report writing – layout and mechanics of research report - references – tables – figures – conclusions. oral presentation – preparation - making presentation – use of visual aids - effective communication	4	10%
MODULE 4 **Research proposals, publications, ethics and IPR** Research proposals - development and evaluation – research paper writing – layout of a research paper - journals in engineering – considerations in publishing – scientometry-impact factor- other indexing like h-index – citations - open access publication -ethical issues - plagiarism –software for plagiarism checking- intellectual property right- patenting case studies	5	10%
SECOND INTERNAL TEST		
MODULE 5 Research methods – Modelling and Simulation Modelling and Simulation – concepts of modelling – mathematical modelling - composite modelling – modelling with – ordinary differential equations – partial differential equations – graphs heuristics and heuristic optimization - simulation modelling	5	10%
MODULE 6 **Research Methods – Measurement, sampling and Data acquisition** Measurement design – errors -validity and reliability in measurement - scaling and scale construction - sample design - sample size determination - sampling errors - data collection procedures - sources of data - data collection methods - data preparation and data analysis	4	10%
THIRD INTERNAL TEST		

07 CE 6409: HYDROINFORMATICS LAB

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Objective : To make the students familiar with the capabilities of GIS and Hydroinformatics

Introduction to GIS	Introduction_ArcGIS
	Introduction_MapWindow
Geo-referencing and Projection	Georeferencing Exercise_ArcGIS
	Digitization Exercise_ArcGIS
	Georeference_MapWindow
	Digitization_MapWindow
Spatial DBMS	Fundamentals of database
	building of database
	Topology Exercise_ArcGIS
Spatial Data Input and Editing	GPS Exercise
	Google Earth Exercise
	Data from CAD software
Spatial Analysis	Buffering Exercise_MapWindow
	Buffering Exercise_ArcGIS
	Watershed Delineation
Cartographic Principles & Design	Symbology_MapWindow
Interpolation	InterpolationExercise_ArcGIS-1

Course Outcomes:

- *Create data from paper maps*
- *Convert other forms of digital data into GIS format*
- *Utilise the capability of GIS for decision making*

References

1. *Chang, K. Introduction to Geographic Information Systems, Tata McGraw Hills Edition, New Delhi*
2. *w.org/apps/wiki/doku.php?id=mapwindow_4_users_manualwww.mapwindo*

Internal continuous assessment: 100 marks

Practical records/outputs	40%
Regular Class Viva-voce	20%
Final Test (objective)	40%

07 CE 6417 INTRODUCTION TO SEMINAR

(L-T-P : 0-0-1) CREDITS: 0 Year: 2015

Pre- requisites:

Nil

Course Objectives:

1. To improve the debating capability of the student to present a general topic
2. To impart training to the student to face audience and present his ideas and thuscreating self esteem and courage essential for an engineer

Outline:

Individual students are required to choose a topic of their interest and give a seminar on that topic for about 30 minutes. A committee consisting of at least three faculty members shall assess the presentation of the seminar. The committee will provide feedback to the students about the scope for improvements in communication, presentation skills and body language.

Course Outcomes:

The graduate will have improved debating capability and presentation skills in any topic of his choice.

07 CE 6402: WATER RESOURCES SYSTEMS ENGINEERING

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-requisites: Nil

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

Syllabus

Water Resource Systems definition and concepts. Description of system components, types and characteristics of systems. Functions of water resource system. Basic problems in system analysis. Basic principles and concept of simulation model. Its components. combination of simulation and optimization. Economic considerations in water resources system. Comparison of alternative plans. Equivalence in kind, equivalence in time. Cash flow diagram. Benefit cost study. Mathematical Modelling of Water Resources. Problem formulation. Constrained and unconstrained optimisation. Lagrange Multiplier. Linear programming. Simplex method, Dual Simplex method. Non-linear programming- one dimensional minimization methods. Newton-Raphson method, interval halving method, Fibonacci method., Golden Section. Dynamic Programming and applications. Introduction, multistage decision problem, Recursive Equations, Curse of Dimensionality.

Course Outcome:

At the end of the course student will be able to

- *Apply concepts of system analysis for planning of water resources systems*
- *Perform basic economic analysis to evaluate the economic feasibility of water resources engineering projects*
- *Formulate and solve deterministic optimization models for design and operation of water resources systems*
- *Formulate and solve multi stage decision problems using dynamic programming*

References:

1. Loucks D. P., Stedinger J. R. and Haith D.A, 'Water Resources Systems Planning and Analysis', Prentice Hall, USA, 1981.
2. Mays L.W and Tung Y-K, 'Hydrosystems Engineering and Management', McGraw Hill, USA, 1992.
3. Vedula S. and Mujumdar P.P., 'Water Resources Systems: Modeling Techniques and Analysis', Tata-McGraw Hill, 2005.
4. Jain S. K. and Singh V.P., 'Water Resources Systems Planning and Management', Elsevier, The Netherlands, 2003.
5. Loucks D. P. and van Beek E., 'Water Resources Systems Planning and Management', UNESCO Publishing, The Netherlands, 2005.
6. A Ravindran, Don T. Philips & James J. Solberg, 'Operations Research – principles and Practice', John Wiley & Sons.
7. Hall.W. A. & Dracup J.A.- 'Water Resources Systems Engineering'
8. Singiresu S. Rao, 'Engineering Optimization Theory and Practice', New Age International (P) Ltd., Publishers, New Delhi.

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6402: WATER RESOURCES SYSTEMS ENGINEERING **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam marks %**
MODULE 1 Water Resource Systems-concepts - definition, description of system – types, components and characteristics of systems. Functions of water resource system. Basic problems in system analysis. **Simulation** – Basic principles and concepts. Components of a simulation model, steps in simulation, combination of simulation and optimization.	**4** **2**	**15**
MODULE 2 Mathematical Modelling of Water Resources: Modelling methods-Simulation versus optimization. decision variables, objective function. Constraints, parameters. Problem formulation and selection. Application to water resources problems and management	**6**	**15**
FIRST INTERNAL TEST		
MODULE 3 Objective function, Maxima, minima and saddle points, convex and concave functions. Constrained and unconstrained optimization. Lagrange multipliers, Kuhn-Tucker conditions.	 **2** **5**	**15**
MODULE 4 **Linear Programming and Application.** General form of LPP, Standard and Canonical forms .Graphical method, Feasible and infeasible solutions. Simplex method. Big-M Simplex Method. Dual problem - Dual Simplex method	**8**	**15**

SECOND INTERNAL TEST		
MODULE 5 **Non-linear programming**- one dimensional minimization methods – Newton-Raphson method, interval halving method, Fibonacci method.- Golden Section. **Dynamic Programming and Applications**. Introduction, multistage decision problem, Recursive Equations, Bellman's Principle of optimality, Shortest route method. Reservoir operation .Curse of Dimensionality.	**4** **4**	**20**
MODULE 6 Economic considerations in water resources system, general principles- discount factors – amortization Comparison of alternative plans. Equivalence in kind, equivalence in time. Cash flow diagram. Benefit cost study—present worth analysis	**2** **5**	**20**

07 CE 6404: ADVANCED GROUND WATER HYDROLOGY

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-requisites: Nil

Objective:

- *To understand the key concepts of ground water occurrence and movement to understand the ground water potential.*
- *To get an exhaustive theoretical approach in planning and design of wells.*

Syllabus

Introduction. Occurrence of ground water, types of aquifers. Aquifer parameters Ground Water movement. Darcy's law, steady unidirectional flow- confined and unconfined aquifer Well Hydraulics. Dupuit's Theory. steady/ uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer, Multiple well systems-partially penetrating wells. Unsteady ground water flow. Non-equilibrium equation of a fully penetrating well in a confined aquifer, solution by Theiss, Jacob's and Chow's methods. Open wells – Design of open well –yield test.- Safe yields, estimation, pumping and recuperation tests. Well loss- determination of well loss by step pumping method. Tube wells. Salt water intrusion. Shape & structure of the fresh & saline water interface, upconing of saline water. Artificial Recharge: Concept, methods, waste water recharge, recharge estimation. Recharge mounds and induced recharge. Water spreading. Surface and Sub-surface investigation of ground water-different methods.

Course Outcomes

- *Understands the availability and movement of groundwater*
- *Design water wells*
- *Identify sites for artificial recharge of Groundwater and determine the consequences of artificial recharge*
- *Conduct Geophysical exploration studies for groundwater source identification*

References:

1. Bear J., Hydraulics of Groundwater, McGrow-Hill International, 1979.
2. Todd D.K., Ground Water Hydrology, John Wiley and Sons, 2000.
3. Driscoll, F., Groundwater and Wells, St. Paul, Minnesota, II Ed., 1986.
4. Raghunath H.M., Ground Water Hydrology, Wiley Eastern Ltd., Second reprint, 2000.
5. Jayarami Reddi, P, A Text Book of Engineering Hydrology, Laxmi Publications
6. O.D.L. Strack, Groundwater Mechanics, Prentice Hall, 1989.
7. S.P. Garg, Groundwater and Tube Wells, Oxford & IBH Publising Co., 1993.
8. K. R. Karanth, "Hydrogeology", TataMcGraw Hill Publishing Company.
9. Literature of the Central Ground Water Board (CGWB);

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 6404 ADVANCED GROUND WATER HYDROLOGY **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 **Introduction**: Occurrence of ground water, geological formations as aquifers, types of aquifers. Aquifer parameters, sp. yield, permeability, porosity, storativity, transmitivity, **Ground Water movement**: Darcy's law, steady unidirectional flow-confined and unconfined aquifer. Base flow to a stream.	**3** **3**	**15**
MODULE 2 **Well Hydraulics**: Dupuit's Theory. steady/ uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer, **Well near aquifer boundaries** -image wells. Multiple well systems-partially penetrating wells	**5** **3**	**15**
FIRST INTERNAL TEST		
MODULE 3 **Unsteady ground water flow**: Non-equilibrium equation of a fully penetrating well in a confined aquifer, solution by Theiss, Jacob's and Chow's methods. Extension to unconfined aquifer situations .	**7**	**15**
MODULE 4 **Open wells** – Design of open well –yield test. Safe yields, estimation, pumping and recuperation tests. Well loss- determination of well loss by step pumping method. Tube wells –design-screened wells-gravel packed wells- -selection of screen size-yield of a well Radial collector wells. Cavity wells and Infiltration galleries	**4** **3**	**15**
SECOND INTERNAL TEST		

MODULE 5 **Saline Water Intrusion in Aquifers** Ghyben-Herzberg relation between fresh & saline waters, shape & structure of the fresh & saline water interface, upconing of saline water, fresh-saline water relations on oceanic islands Artificial Recharge: Concept, methods, waste water recharge, recharge estimation. recharge mounds and induced recharge. Water spreading	**4** **3**	**20**
MODULE 6 **Surface investigation of ground water** Geological method/ remote sensing / electric resistivity /seismic refraction based methods for surface investigation of ground water**.** **Sub-surface investigation of ground water**, Test drilling & ground water level measurement, sub-surface ground water investigation through geophysical / resistivity /spontaneous potential /radiation / temperature / caliper / fluid conductivity / fluid velocity /miscellaneous logging.	**3** **4**	**20**

07 CE 6406: REMOTE SENSING

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Prerequisites : 07CE6405

Course Objectives:

- *To provide a comprehensive knowledge about photogrametry, GPS and satellite remote sensing*
- *To equip the student with image processing capabilities so that they can build remote sensing applications*

Syllabus:

Photogrammetry-Geometric characteristics of aerial photographs. GPS and its system - Introduction to remote sensing –Electro- magnetic spectrum and its interaction. Sensors–along the track Scanners and across the track scanners -Satellite system parameter. Visual and digital image processing - image enhancement- image classification. Application of remote sensing

Course Outcomes

- *Use photogrammetry and GPS for finding heights and relief displacement*
- *Use knowledge in electromagnetic spectrum and its interactions with various types of media for deriving useful information from satellite imagery*
- *Interpret satellite images visually and digitally*
- *Apply the image processing techniques to derive the useful information from satellite images*

Text book:

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.

References

1. F.F Sabins(Jr.), *Remote Sensing : Principals and Interpretation*, Freeman & Co., San Francisco, 1978
2. George Joseph, *Fundamentals of Remote Sensing*, University Press, 2005.
3. R.N. Colwel (Ed.), *Manual of Remote Sensing*, Vol. I & II, American Society of Photogrammetry and Remote Sensing, Falls Church, Va. (1983)
4. Keith P.B., Thompson et. al. (Ed.), *Remote Sensing and Water Resources Management*, American Water Resources Association, Urbana Illinois, 1973.
5. NRSA, E-book on remote sensing applications, published by NRSA 2010.
6. Hoffman-Wellenhof B., *GPS theory and Practice*, Springer Wien, New York, 1997
7. Sickle J.V., *GPS for Land Surveyors*, Ann Arbor Press, Chelsea, 1996
8. Kavanagh, B.F., 2003, *Surveying principles and applications*, Prentice Hall: New Jersy.
9. Agarwal, C. S., and Garg, P. K., Textbook on Remote Sensing in Natural Resources Monitoring and Management, Wheeler Publishing , Allahabad, 2000 2.

10. Meijerink M. J., de Brouwer, H.A.M., Mannaerts, C. M., and Velenzuela, C. R., Introduction to the Use of Geographical Information Systems for Practical Hydrology, ITC publication no. 23, UNESCO, Paris, 1994

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6406: REMOTE SENSING **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 ***Photogrammetry :***Geometric characteristics of aerial photographs – Photographic Scale – Photo coordinates and ground coordinates– Relief displacement- Stereoscopy- Image Parallax- Ground Control- Flight planning- ortho photos – Introduction to Digital Photogrammetry	**7**	**15**
MODULE 2 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. Indian Regional Navigation Satellite System. 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.	**7**	**15**
FIRST INTERNAL TEST		

MODULE 3 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. 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.	**7**	**15**
MODULE 4 Basic principles of digital image processing -Image restoration: Radiometric and geometric corrections, georeferencing, image statistics, histograms and scatter plots. Image enhancement– Radiometric: Contrast enhancement and density slicing; spatial filtering, texture and edge enhancement; Multispectral: ratio images (indices).	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Use of Principal component analysis and IHS transformation: Freque transformation (Fourier transforms) for image processing. Im Classification –Supervised: minimum distance to mean, parallelepi maximum likelihood and training. - unsupervised: single pass and itera –Hybrid classification-classification of mixed pixels-post classifica smoothing. Classification accuracy assessment.	**7**	**20**
MODULE 6 ***Applications of Remote Sensing*** – Land use and land cover mapping – Geologic and soil mapping – Terrain classification and evaluation – Wa Pollution detection- Flood mapping- snow mapping- Urban and regiona planning. Case studies: (A group of 3 or 4 students will take up an application in any one of the topics related to water resources and hydroinformatics and present this case study)	**7**	**20**

07 CE 6414: WATER POWER ENGINEERING

(L-T-P: Credit): 3-0-0:3 Year :2015

Objective:

- *To introduce the students to the essentials of the water power engineering*
- *To equip the students to design the various hydraulic components of water power generation*

Syllabus

Introduction: Sources of energy, types of power, types of hydropower schemes and their general layouts. Concept of Power transmission. Estimation of Hydropower. Nature of demand: Load curves, load duration curves, load factor. Intakes. Conveyance System. General concepts of design and the economics. Protection devices: Surge tank air cushion chamber

Power Station: Types, elements of a power station. Pumped storage plants: Concepts, general layout, types and economics. Turbines: Classification, characteristics of different types, choice of types. Turbine setting and cavitation. Tail race:. Tidal power stations: Concepts, general layout, classification, types. Introduction to hydraulic transients- Governing Equations in transient flow and Numerical Modelling concepts-Applications. Other types of power plant

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-and Sharma N.K. "Water Power Engineering, Vikas Pub. House Pvt. Ltd.
4. Jog M.G. Hydro Electric and Pumped Storage Plants,
5. CBIP , Manual on Development of Small HydroElectric Projects, CBIP
6. H K Barrows, Water Power Engineering, Second Edition, , Mc Graw Hill Book Company 1934.

Course outcome:

- *Estimate hydropower potential*
- *Design penstocks and surge shafts*
- *Select appropriate turbine for a power plant and design its components*

Internal continuous assessment: 40 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 two tests per subject.

iii) Two internal tests, each having 15 marks

iv) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6414: WATER POWER ENGINEERING (L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 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 available head.	**7**	**15**
MODULE 2 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	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Conveyance System: Power channel, pressure conduits, tunnels. General concepts of design and the economics. Protection devices: Surge tank-Function, location, types such as simple, restricted orifice, differential, air cushion chamber type -Basic design criteria, Forebay (introduction only).	**7**	**15**
MODULE 4 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.	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Pumped storage plants: Concepts, general layout, types and economics. Turbines: Classification, characteristics of different types, choice of types. Turbine setting and cavitation Tail race: Functions, types (channel and tunnel) Draft tubes, function and principal types.	**7**	**20**
MODULE 6 Tidal power stations: Concepts, general layout, classification, types. Introduction to hydraulic transients- Governing equations in transient flow and Numerical modelling concepts-Applications. Other types of power plant :(a)Depression power plant (b) Micro Power Station – Need for the development and the problems faced	**7**	**20**

07 CE 6416 DAM REHABILITATION ENGINEERING

(L-T-P: Credit): 3-0-0:3 Year :2015

Objective:

T**his course would enable the student to:**

- Appreciate the role of dams in water conservation.
- Familiarize dams of national importance, understand the structural components of dams and its functions and understand the rehabilitation works required for dams

Syllabus

Dams. Types of dams. Dams of national Importance. Major Dams of Kerala. Structural Components of Dams. Environmental Considerations in Dam Management. Major Dam Failure Case Studies. Flood Operation of Reservoirs – Formulation of Flood .Dam Break Analysis . Inundation Mapping. Emergency Action Plan. Dam safety monitoring set up in india – DRIP. Optimization of Reservoir Operations. Simulation Models. Seepage Chemistry Registers of Daily Monitoring. Instrumentation. Pressure, Seepage, Movement and Vibration Measurement -Types and Procedures. Dam Safety Inspection. and Hydrologic Considerations – Structural Considerations. Seepage and Leakage Prevention Rehabilitation Case studies. Decommissioning of Dams.

Course Outcome:

- *Understand the importance of dam safety and its procedures*
- *Get introduced to instrumentation of dams*
- *Get an awareness on flood operation rules of dams*
- *Independently handle sustainable management of a large dam*

References:

1. *Varshney, R. S. Concrete Dams, Published by Oxford & IBH Publishing Co., New Delhi,*
2. CWC, Guide for Hydrologic Processes
3. CWC, Report on Dam Safety Procedures
4. CWC, Standardized Data Book Format, Sample Checklist and Performa for Periodical Inspection
5. CWC, Guidelines for Safety Inspection of Dams
6. CWC, Guidelines for Development and Implementation of EAP
7. ASDSO Seepage Chemistry Manual
8. ASDSO Suggested References for State Dam Safety Program
9. USBR Concrete Dam Instrumentation Manual

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6416 DAM REHABILITATION ENGINEERING **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Dams – Types of dams – Large Dams – ICOLD – NRLD – Dams of national Importance – Major Dams of Kerala – Structural Components of Dams — Power Tunnel Intake - Dam Foundation- Dead Storage of Dams –- (Optional Field Visit to a Large Dam)	**7**	**15**
MODULE 2 Spillway – Spillway Gates – Gallery - Reservoir Rule Curves – Sedimentation – Assessment of Sedimentation – Canal Sluice – River Sluice. Environmental Considerations in Dam Management- – Major Dam Failure Case Studies	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Flood Operation of Reservoirs – Formulation of Flood Rules – Static and Dynamic Flood Rules – Flood Warnings and Communication – Dam Break Analysis – Inundation Mapping – Emergency Action Plan – Dam Safety Monitoring Set Up in India – DRIP.	**7**	**15**
MODULE 4 Monitoring of Dams – Daily Monitoring – Meteorological Observations – Water Level – Seepage – Outflows – Inflow – Outflow Computations – Optimization of Reservoir Operations – Simulation Models - Seepage Chemistry - Registers of Daily Monitoring – Information System for Daily Monitoring.	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Instrumentation – Pressure, Seepage, Movement and Vibration Measurement -Types and Procedures. Dam Safety Inspection – Data Book – Sample Checklist – Performa for Periodical Inspection – Hydraulic and Hydrologic Considerations – Structural Considerations.	**7**	**20**
MODULE 6 Seismic Stability - Dam Rehabilitation – Spillways – Seepage and Leakage Prevention – Grouting and other methods – Water front surface treatments – Rehabilitation Case studies – Decommissioning of Dams.	**7**	**20**

07 CE 6418: FLUVIAL HYDRAULICS

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Objective: To make the student aware of

- *the river Characteristics and behaviour of the rivers*
- *the importance of bank protection the various methods of protection.*
- *the Design methods of stable channels.*
- *the concepts of sediment properties and flow profiles*
- *the concepts of sediment transport and its assessment*
- *the various theories regarding the transportation of sediments*

Syllabus:

River Characteristics; River behavior; Stream Profiles; Stabilization and rectification of rivers; Design of Stable channels; Sediment Engineering; Regimes of flow; Incipient motion; Sampling of Sediment Load; Bed load transport; Suspended load transport.

-

Course Outcome:

Students who successfully complete this course will be able

- To understand all features of River. With the thorough knowledge about the river.
- It will be possible to train it to meet the various human needs.
- It will be possible to assess the sediment quantity that can be drawn from a river for construction purpose and also to calculate the life of reservoir.

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: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 6418 FLUVIAL HYDRAULICS **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 River Characteristics**:** River morphology- Physical characteristics – Channel configurations such as straight channel, meandering channel, braided channel – Transitions - Cutoffs - Deltas.. River behaviour**:** Channel geometry- equilibrium, aggradations and degradation - Effects of long contraction - Effects of over bank flow - Super critical flow in rivers.	**7**	**15**
MODULE 2 Stream Profiles: Stream profiles and bed material- Bank erosion – Importance of bank erodability. Stabilization and rectification of rivers: Alignment- Radius of curvature – Revetments - Hydraulic models for river engineering.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Design of Stable channels: Stable channels carrying sediment laden water in Alluvial Materials -Blench's Method of Design – Tractive Force Method of Design – Application of optimization Principles to Channels Design.	**7**	**15**
MODULE 4 Sediment Engineering: Origin and formation of sediments - Fundamental properties of individual sediment particle - Bulk properties of sediments**.** Regimes of flow: Description of regimes of flow, origin and characteristics, importance	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Incipient motion: Competent Velocity- Brahms & Airy's concept- Lift concept - Critical Tractive force- Shield analysis. Sampling of Sediment Load:– Sampling of bed load and suspended load in streams - Bed load samplers - Suspended load samplers	**7**	**20**
MODULE 6 Bed load Du-Bouy's equation, Einstein's equation – Saltation. Suspended load transport: Method of Integrating Curves - Einstein's Approach- Simple Relations for suspended load.	**7**	**20**

07 CE 6422: GROUND WATER CONTAMINATION AND POLLUTION TRANSPORT
L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Objective:

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

Syllabus

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 principlesEquations of ground water flow.

Resource evaluation: development of ground water resources-Exploration of Aquifers-the response of ideal aquifers to pumping. Numerical simulation for aquifer yield prediction-Artificial recharge

Chemical properties and principles: constituents -chemical equilibrium-association and dissociation of dissolved species. 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. Solute transport: water quality standards-transport process. Hydro chemical behaviour of contaminants-trace metals-nitrogensources of contamination-land disposal of solid waste-sewage disposal on land. USGS-Moc model: modelling principles-MOC modelling.

Course outcomes:

- *Get fundamental Concepts of Groundwater Flow, Transport and Contamination*
- *Demonstrate conceptual understanding of the contamination of the soil and groundwater media*
- *Explain the governing processes and identify factors controlling transport and fate of contaminants in soil and groundwater*
- *Suggest most suitable remediation technologies for real life contamination problems*

References

1. Randall J. Charbeneau-Ground water Hydraulics and Pollutant Transport
2. Allen Freeze R. and John A. Cherry -Ground water. Prentice Hall.Inc
3. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.
4. Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 6422: GROUND WATER CONTAMINATION AND POLLUTION TRANSPORT **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
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 l-piezometers and nests. Hydraulic conductivity and permeability-homogenicity and anisotropy-porosity and voids ratio.	**7**	**15**
MODULE 2 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.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 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.	**7**	**15**
MODULE 4 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.	**7**	**15**
SECOND INTERNAL TEST		

MODULE 5 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. Sources of contamination -land disposal of solid waste - sewage disposal on land.	**7**	**20**
MODULE 6 Solute transport: water quality standards-transport process-non reactive constituents in homogeneous media-transport in fracture media-hydro chemical behaviour of contaminants-trace metals-nitrogen-trace non-metals-organic substances-measurement of parameters – velocity-dispersivity-chemical partitioning. USGS-Moc model: modelling principles-MOC modelling.	**7**	**20**

07 CE 6424: DATA ACQUISITION IN HYDROINFORMATICS

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Prerequisites : 07CE6405

Course Objectives:

- *To provide in depth knowledge to the student regarding various options of data acquisition system required for processing the data in Hydroinformatics*

Syllabus

Automatic and digital levels, EDM total station principle-errors data transfer-file formats- coordinate systems- Global position system -NAVSTAR, GLONASS, GALILEO. Satellite orbits-Coordinates systems. signal structure Errors and bias- ephemeris- Planning and observation. Conversion from cad files – file conversion modules. Maps preparation

Course outcome

Plan and Collect data acquisition programme for building GIS data

Use GPS technology for the data collection for GIS data base

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: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 6424: DATA ACQUISITION IN HYDROINFORMATICS **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Use of automatic and digital levels, electronic theodolites, total stations, Principle of EDM and electronic theodlite. Method of assessing errors	**7**	**15**
MODULE 2 Data acquisition and transfer of data from machine to computer system -formats used. Use of total station for collecting GIS compatible data-file formats- File transfer. Introduction to GPS – Basic components	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Satellite Navigational Systems. **Global Positioning Systems:** (NAVSTAR, GLONASS, GALILEO). Indian Regional Navigation Satellite System.	**7**	**15**
MODULE 4 **Signal structure-** pseudo range and carrier phase measurements, signal structure, GPS coordinate systems:	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 GPS time; GPS Errors and biases; GPS orbital Geometry and Navigatic solution; Surveying with GPS; Planning and field observations; Data pc processing; GIS and GPS integration;	**7**	**20**
MODULE 6 Differential GPS, Component of base station and rouver -Real time processing and Post processing. Map concepts, co-ordinates and Map projection. Control surveys using GPS, triangulation methods (adjustme and computations of coordinates); Cartography and report writing.	**7**	**20**

07 CE 6114 WATER POLLUTION CONTROL AND STREAM SANITATION

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre- Requisites: Basic mathematics

Course Objectives:

- *To make the students aware about the sources of surface water pollution, their control and stream quality standards*
- *To create awareness about the various stream sanitation practices to protect the natural resources.*
- *Able to describe the major sources of water, soil, and sediment pollution and methods for their management.*

Syllabus

Introduction-importance of water sources-socio-economic importance-sources of pollution-types of waste- sources of stream pollution -location and management of waste loads- assessing the carrying capacity of receiving water bodies-Water quality and stream quality standards-Eutrophication-organic pollution-oil pollution-radioactive pollution-marine pollution-thermal pollution-pesticide pollution-heavy metal pollution. Organic self purification- oxygen sag curve-Streeter Phelp's equation-Critical deficit-problems- Microbial self purification-Classification of streams-natural self purification process-disposal of wastewater-Rational stream sanitation practices-dual objectives of stream sanitation practices- stream survey-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. Impacts of river developments on waste assimilation capacity-detrimental and beneficial effects-hydroelectric power-navigation works-flood control works-irrigation and other diversions.

Course Outcomes:

- Capable to formulate and solve various water pollution problems both quantitatively and qualitatively.
- Able to understand, predict and quantify the impacts of various industrial discharges and river development works.
- Application of mathematical techniques to quantify the above.

Text Books:

1. P. K. Goel, Water pollution, causes, effects and control, New Age Publishers
2. Phelps E. Stream Sanitation, J.Wiley Publishers

References:

1. Roy M Harrison, Pollution Causes, effects and control, Royal Society of Chemistry
2. Clarence J Velz, Applied stream sanitation, John Wiley & Sons
3. Todd G. K. Applied Groundwater hydrology

07 CE 6114 WATER POLLUTION CONTROL AND STREAM SANITATION (L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem. Exam Marks %**
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-	**6**	**15**
MODULE 2 Assessing the carrying capacity of receiving water bodies. Water quality and stream quality standards Eutrophication-organic pollution-oil pollution-radioactive pollution-marine pollution-thermal pollution-pesticide pollution-heavy metal pollution	**6**	**15**
FIRST INTERNAL TEST		
MODULE 3 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.	**7**	**15**
MODULE 4 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	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 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	**8**	**20**
MODULE 6 Impacts of river developments on waste assimilation capacity-detrimental and beneficial effects-hydroelectric power-navigation works-flood control works-irrigation and other diversions	**8**	**20**

07 CE 6106 ENVIRONMENTAL IMPACT ASSESSMENT

(L-T-P: Credit): 3-0-0: 3 Year :2015

Pre-requisites: nil

Course Objectives:

- 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.
- To provide an understanding of the basic principles and technical and social limitations of an EIA
- Introduces basic scientific knowledge necessary to understand the nature of environmental problems and to be able to quantify them

Syllabus:

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- Air quality impact analysis - Noise impact analysis-Visual impact analysis- Energy impact analysis-Energy impact considerations, organization and methodology. Water quality impact analysis - Vegetation and wildlife impact analysis -Environmental monitoring and auditing.Summarization of Environmental Impact –Checklist method, Matrix method, Network method.

Course Outcomes:

- Gain basic knowledge and understanding of the role of EIA in environmental management for sustainable develop
- Gain awareness regarding ecologically sustainable development and environmental friendly technologies and also the regulatory provisions for environmental protect
- Undertaking of EIA studies and able to quantify EIA and make EIA report

References:-

1. John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company.
2. Larry W. Canter –Environmental Impact Assessment, Mcgraw-Hill international Editions.
3. Suresh K.Dhameja-Environmental Engineering and Management, S.K. Kataria & Sons
4. Davis, M.L., and Cornell, D.A. Introduction to Environmental Engineering, Mc Graw Hill International Editions, 1998.
5. www.moef.nic.in
6. EIA Guidelines, Notification of Govt of India, Environment Impact Assessment, 2006

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks
ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course plan

07 CE 6106 ENVIRONMENTAL IMPACT ASSESSMENT (L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Concept of environmental impact analysis - Legislations, laws and Acts relevant to Environmental protection in India-The environment (protection)Act,1986- The Air(prevention and control of pollution)Act,1981- The Motor Vehicle Act,1988 -The Water(prevention and control of pollution)Act,1974- Wildlife protection Act,1972- Indian Forest Act,1927.	**7**	**15**
MODULE 2 Concept of environmental impact analysis - Legislations, laws and Acts relevant to Environmental protection in India-The environment (protection)Act,1986- The Air(prevention and control of pollution)Act,1981- The Motor Vehicle Act,1988 -The Water(prevention and control of pollution)Act,1974- Wildlife protection Act,1972- Indian Forest Act,1927.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 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.	**7**	**15**
MODULE 4 Visual impact analysis- conceptual approach for visual impact prediction and assessment. Energy impact analysis- Energy impact considerations, organization and methodology.	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Water quality impact analysis – water quality criteria and standards – Environmental setting- modeling - water quality impacts by projects like highways, power plants, mining, agriculture and irrigation, forest management.	**7**	**20**
MODULE 6 Vegetation and wildlife impact analysis – Environment assessment – assessment methodologies. Environmental monitoring and auditing. Summarization of Environmental Impact –Checklist method, Matrix method, Network method	**7**	**20**

07 CE 6408: SEMINAR

(L-T-P : 0-2-0) CREDITS: 2 Year: 2015

Objective:

To assess the debating capability of the student to present a technical topic.

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.

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. The seminar shall be of 30 minutes. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. 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 Department Library.

A committee constituted within the department shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee/students.

Course outcome :

- To face the audience with confidence and self esteem
- To have Debating capability and presentation skills in a technical topic of his interest.
- Develop the knowledge about contemporary issues and research opportunities
- To communicate effectively and professionally in both verbal and written forms
- Capability for self education and lifelong learning

Internal continuous assessment: 100 marks

Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar. Distribution of marks for the seminar is as follows.

Marks for the report:	30%
Presentation:	40%
Ability to answer questions on the topic	30%

07 CE 6426 MINI PROJECT

(L-T-P : 0-0-4) CREDITS: 2 Year: 2015

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*
- *Run as a for runner for master research project*

Guideline

The mini project work can be a computer based modelling project or field work on any of the topics in Water Resources and Hydroinformatics or related topics. The student has to demonstrate a case study by means of the already available professional software. A field work related to the field of Water Resources and Hydroinformatics can also be conducted as a mini project work. The project work is allotted individually/group on different topics.

Department will constitute an Evaluation Committee to review the project work. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the outcome of the work.. The Evaluation committee consists of at least three faculty members of which one should be internal guide.

Course outcome

- Have confidence in taking up field problems and model it using any of the existing modelling software related to Water Resources and Hydroinformatics
- Take up a field survey or work to solve a problem in Water Resources and Hydroinformatics
- have sustainable perspective for designing environment friendly development programmes for the society
- Gain right outlook to maintain professional code of practice and ethics
- Critically evaluate financial viability and implementation feasibility of various engineering solutions
- Get hankering for Lifelong learning.

Internal continuous assessment: 100 marks

Total marks : 100marks

Project Progress evaluation:

Progress evaluation by the Project Supervisor : 40 Marks

Presentation and evaluation by the committee : 60 Marks

07 CE 6412: HYDRO-MODELING LAB
(L-T-P : 0-2-0) CREDITS: 2 Year: 2015

Objective :
To give effective hands on the field tests and modelling exercises

Syllabus

Hydrologic Experiments

Infiltrometer-Fitting of Horton's model and other models

Hydrologic set up- Verification of water accounting 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.

Modeling exercises

SUH Generation and its application

Runoff prediction using HEC HMS

Flood modeling using HEC Geo RAS and HEC RAS

Pipe flow and surge analysis using SURGE

Arc SWAT or MW SWAT application

Course Outcomes:

- *Conduct yields test of well*
- *Devising experimentation for conducting a water accounting study*
- *Determine the design flood*
- *Analyse the watershed and derive discharge*
- *Model transient*
- *Application of mathematical techniques to quantify the above.*

Reference:

- *Chaudhry, H. Open Channel Hydraulics. Springer Science & Business Media.*
- *Subramanya, K, "Engineering Hydrology", Tata McGraw Hill*
- *Raghunath H.M., Ground Water Hydrology, Wiley Eastern Ltd., Second reprint, 2000.*
- *CWC , Flood estimation manual for west coast Konkan andMalabar zones5(1)and (b) Report no.K&M/19/1992*
- *HEC User manual for HEC HMS, HEC geoRAS and HEC RAS*
- *Chaudhry, H. Applied Hydraulic transients.Springer.*

Internal continuous assessment: 100 marks

Practical records/outputs	40%
Regular Class Viva-voce	20%
Final Test (objective)	40%

07 CE 7405: GROUNDWATER MODELLING AND MANAGEMENT

(L-T-P: Credit): 3-0-0:3 Year :2015

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.*

Syllabus

Water potential assessment: Investigation and evaluation – Geophysical methods. Application of remote sensing techniques. Assessing yield. Physical models – Analog models – Mathematical modelling – Unsaturated flow models. Numerical modelling of groundwater flow – Finite Differential equations - Finite difference solution and Finite element method. Contaminant transport theory – Advection, dispersion equation –Hydrodynamic dispersion – Analytical models – Numerical simulation of solute transport- Density driven flow - Heat transport. **D**ata requirements – Conceptual model design : Conceptualization of aquifer system – Parameters, Input-output stresses, Initial and Boundary conditions - Model design and execution. Transient simulation – Model calibration : steady state and unsteady state Introduction to software for groundwater modelling under open source and proprietary schemes. Optimal groundwater development – Indian GEC norms – Conjunctive use models. Modelling multilayer groundwater flow system -Modelling contaminant migration – Modelling fracture flow system – Artificial recharge feasibility through modelling. Stochastic modelling of groundwater flow - Groundwater contamination, restoration and management

Course Outcomes:

- *Explain in detail how groundwater systems function;*
- *Describe the interactions between groundwater systems and surface waters*
- *Understand the nature of conceptual, mathematical and numerical models of groundwater systems*
- *Develop a conceptual model of a groundwater flow system from typical data sets;*
- *Translate a conceptual model into a numerical model;*

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: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 7405 GROUNDWATER MODELLING AND MANAGEMENT **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
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	**7**	**15**
MODULE 2 Physical models – Analog models – Mathematical modelling – Unsaturated flow models Numerical modelling 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	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Physical models – Analog models – Mathematical modelling – Unsaturated flow models Numerical modelling 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	**7**	**15**

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	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Introduction to software for groundwater modelling under open source proprietary schemes. Optimal groundwater development – Indian GEC norms – Conjunctive use models Modelling multilayer groundwater flow system.	**7**	**20**
MODULE 6 Modelling contaminant migration – Modelling fracture flow system – Artificial recharge feasibility through modelling – Simulation of movements of solutes in unsaturated zone – Stochastic modelling of groundwater flow - Groundwater contamination, restoration and management.	**7**	**20**

07 CE 7407: ADVANCED FINITE ELEMENT METHODS

(L-T-P: Credit): 3-0-0:3 Year :2015

Pre-requisites

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

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.*

Syllabus

Introduction – review of computational procedures with 1D and 2D elements - choice of interpolation functions - convergence and completeness conditions – modelling considerations – symmetry - applications. isoparametric formulation – 1D and 2D elements – numerical integration – choice in numerical integration – patch test. Coordinate transformation . Imposition of constraints –error estimates. Boundary value problems – weak and strong forms –applications to structural, thermal and fluid flow problems. Finite element formulation for non-linear problems – solution methods - 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.

Course Outcomes:

- *To understand the fundamental concepts of the theory of the finite element method*
- *Formulate simple problems into finite elements*
- *Be able to derive equations in finite element methods for 1D, 2D and 3D 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*, TataMcGraw 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: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 7407 ADVANCED FINITE ELEMENT METHODS (L-T-P : 3-0-0) CREDITS:3		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Introduction – review of computational procedures with 1D elements – interpolation and shape functions – 2D elements – simple solid element – element matrices for structural mechanics, heat transfer and fluid flow problems.	**7**	**15**
MODULE 2 Introduction – review of computational procedures with 1D elements – interpolation and shape functions – 2D elements – simple solid element – element matrices for structural mechanics, heat transfer and fluid flow problems.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 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.	**7**	**15**
MODULE 4 Boundary value problems – weak and strong forms – functionals – Euler-Lagrange equations – Rayleigh-Ritz method – finite element formulation from functional. Weighted-residual methods – Gelerkin, least-square and collocation methods – Gelerkin finite element formulation – applications to structural, thermal and fluid flow problems.	**7**	**15**
SECOND INTERNAL TEST		

MODULE 5 Finite element formulation for non-linear problems – solution methods Newton-Raphson method – modified Newton-Raphson method – convergence criteria – applications.	**7**	**20**
MODULE 6 Transient finite element procedures – FE equations and matrices - integration techniques – applications. Introduction to coupled analyses (fluid-structure interaction, thermo-mechanical problems) and contact problems.	**7**	**20**

07 CE 7409: NUMERICAL METHODS

(L-T-P: Credit): 3-0-0: 3 Year :2015

Objective:

- *To equip the students to develop numerical models for engineering applications*

Syllabus

Solution of algebraic and transcendental equations- Generalized Newton- Raphson method for multiple roots- Newton's method for non-linear systems. Solution of simultaneous equations- ill conditioning- pivoting –convergence-Eigen value problems-Vector iteration method. Interpolation-Inverse interpolation –Error estimates-Double interpolation-Trigonometric interpolation. Numerical differential-Numerical integration- Error estimates-Double integration. Curve fitting-method of least squares – non-linear relationships – Correlation and Regression – Multiple linear regressions. Solution of ordinary differential equations-. stability of solution – simultaneous first order differential equations - higher order difference 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.

Course Outcomes:

- *The use of numerical method with proper understanding of the limitations and shortcomings*
- *Analyze the applicability and accuracy of matrix numerical solutions to linear systems of equations*
- *Apply numerical solutions to differential equations to build numerical models of civil engineering systems*

References:

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

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 7409: NUMERICAL METHODS **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Solution of algebraic and transcendental equations- Review and comparison of various iterative methods, convergence- Generalized Newton- Raphson method for multiple roots.	**7**	**15**
MODULE 2 Higher order methods- Newton's method for non-linear systems. 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	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Interpolation- Newton's divided difference, Lagrange, Aitken, Hermite and Spline techniques – Inverse interpolation –Error estimates-Double interpolation-Trigonometric interpolation.	**7**	**15**
MODULE 4 Curve fitting-method of least squares – non-linear relationships – Correlation and Regression – Linear Correlation – Measure of correlation – Standard error of estimate – Coefficient of correlation – Multiple linear regressions.	**7**	**15**
SECOND INTERNAL TEST		

MODULE 5 Numerical differentiation-Numerical integration-Newton–Cote's integration formula-Gauss quadrature –Error estimates-Double integration. Solution of ordinary differential equations-Single step & multi step methods- Euler method, Modified Euler, Ranga- Kutta method. stability solution – simultaneous first order differential equations - higher order difference equations. Numerical solution of integral equations.	**7**	**20**
MODULE 6 Partial differential equations – classification – Laplace equation, ID wave equation, ID heat equation – Finite difference method – Relaxation methods. Stability and convergence of solution.	**7**	**20**

07 CE 7411: COMPUTATIONAL FLUID DYNAMICS

L-T-P: Credit): 3-0-0: 3 Year :2015

Prerequisites :

Course Objectives:

- *To introduce and develop the main approaches and techniques that constitute the basis of numerical fluid mechanics for engineers and applied scientists, for solving the problems in compressible and incompressible flow.*
- *To familiarise students with the numerical implimentation of these techniques and numerical schemes so as to provide them with the means to write their own codes and software and so accure the knowledge necessary for the skillful utilization of CFD packages or other more complex software.*

Syllabus

System and control volume approaches, Derivation of flow governing equations, Reynold's transport theorem, Navier – Stoke's equations , Energy equations and Boundary layer equation.

Formulation of Stream function, Potential flow and various combinations of simple type potential flows, turbulence modelling. Discretization of the governing equations using finite difference and finite volume methods, concepts of consistency, stability and convergence. Time dependent problems, Explicit, Implicit and Crank-Nicolson schemes.

Finite volume method for compressible and incompressible flows, Vertex centered and cell centered, Upwind, hybrid, upwind least square reconstruction and QUICK schemes, SIMPLE, SIMPLER and projection methods, Artificial diffusion – Structured and unstructured grids – Solution of system of equations , Tridiagonal matrix algorithm

Course Outcomes:

- *Improve the student's understanding of the basic principles of fluid mechanics.*
- *Provide the student with a basic understanding of the theory, principles, and widely used techniques in the numerical solution of fluid equations*
- *Recognize the type of fluid flow that is occurring in a particular physical system and to use the appropriate model equations to investigate the flow.*

References:

1. J D Anderson: Computational Fluid Dynamics – McGraw 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, MilovanPeric: Computational Methods for Fluid Dynamics.

7. Charles Hirsch: Numerical Computation of Internal and External Flows,Vol 1 & 2, A Wiley – Interscience Publication.
8. H.K. Versteeg and W. Malalasekera- An introduction to Computational Fluid Dynamics.
9. http://www.fluidyn.com

Internal continuous assessment: 40 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 two tests per subject.

iii) Two internal tests, each having 15 marks

iv) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 7411: COMPUTATIONAL FLUID DYNAMICS **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Philosophy of Computational Fluid Dynamics, forms of Governing equations particularly suitable for CFD. Reynold's transport theorem – Conservation of mass, momentum and energy equations –Navier – Stoke's equations – Energy equation – Boundary layer equation.	**7**	**15**
MODULE 2 Philosophy of Computational Fluid Dynamics, forms of Governing equations particularly suitable for CFD. Reynold's transport theorem – Conservation of mass, momentum and energy equations –Navier – Stoke's equations – Energy equation – Boundary layer equation.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Discretization - Finite difference schemes – Backward - Central and forward schemes (review only) – Time dependent problems - Explicit scheme– Stability analysis – Implicit and Crank-Nicolson schemes. Simple CFD techniques -Lax-Wendroff, Mac-Cormack's techniques.	**7**	**15**
MODULE 4 Finite volume method for incompressible flows – Vertex centered and cell centered FVM – One Dimensional steady state diffusion -2D and 3D diffusion problems. 1D steady convection and diffusion- Upwind, hybrid, upwind least square reconstruction and QUICK schemes.	**7**	**15**

SECOND INTERNAL TEST		
MODULE 5 Staggered and collocated grids – Solution algorithms for both types – Evaluation of velocity field – SIMPLE, SIMPLER and projection methods. Finite volume method for compressible flows- 1D steady heat conduct Explicit scheme – Crank-Nicolson scheme - Fully Implicit scheme .	**7**	**20**
MODULE 6 Treatment of convection terms – Flux vector splitting method - Artificial diffusion – Structured and unstructured grids – Solution system of equations – Tridiagonal matrix algorithm – Line by line sol Development of a computer program for the analysis of incompress flows in two dimensions	**7**	**20**

07 CE 7413: SOFT COMPUTING TECHNIQUES

L-T-P: Credit): 3-0-0: 3 Year :2015

Prerequisites : Nil

Course Objectives:

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

Syllabus

Artificial neural network Basic concepts-Types of Neural network Architectures- learning rules-Learning paradigmsBack Propagation networks- efficiency and accuracy of BPN. Other pattern mapping algorithms - Recurrent Networks –Auto associative and bidirectional associative networks-Hopfield network- Kohonen Self organizing maps-counter propagation network and Adaptive resonance theory. Introduction to Fuzzy logic: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Fuzzification- Defuzzification- Fuzzy logic controller(Block Diagram). **Fundamentals of genetic algorithms:** Basic concepts- working principle – Crossover -mutation-convergence of genetic algorithm. **Hybrid systems:**–Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids-Genetic algorithm based back propagation network- Fuzzy back propagation networks.

Course Outcomes:

- *Apply various neural network architectures to solve problems in Engineering in general and water resources in particular*
- *Distinguish between crisp and fuzzy system and develop application*
- *Develop genetic algorithm solution for Water resources engineering problems*
- *Apply combinations of these technologies for building application*

Text Book

1. Sivanandan,S.N. and S.N.Deepa, *Principles of Soft Computing*, Wiley India.
2. S.Rajasekharan, G.A.Vijayalakshmi Pai, *Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications*, Prentice Hall India.

References

1. S.Haykins, *Neural Networks a Comprehensive foundation*, Pearson Education.
2. Timothy J Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill, New York.
3. D.E.Goldberg, *Genetic Algorithms in Search Optimisation and Machine Learning*, Pearson Education.

Internal continuous assessment: 40 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 two tests per subject.

i) Two internal tests, each having 15 marks

ii) Tutorials/Assignments having 10 marks

End Semester Examination: 60 marks

Course Plan:

07 CE 7413: SOFT COMPUTING TECHNIQUES **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 **Artificial Neural Networks**: Basic concepts-Types of Neural Network Architectures-Single layer feed forward network-Multilayer feed forward network-Characteristics of Neural Networks-learning rules-Error correction and Hebbian learning. Learning paradigms-unsupervised, supervised and reinforcement learning. Perceptron networks-Back Propagation networks-sigmoidal non-linearity-learning rate momentum factor. Stopping criteria. Other factors controlling the efficiency and accuracy of BPN	**7**	**15**
MODULE 2 Other pattern mapping algorithms -Radial basis function network and Cascade correlation network. Comparison of BPN with Radial basis function-Recurrent Networks - Auto associative and bidirectional associative networks- Hopfield network- Kohonen Self organizing maps-counter propagation network and Adaptive resonance theory	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 **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-	**7**	**15**
MODULE 4 Fuzzy arithmetic fuzzy ordering and fuzzy measures. Fuzzy Rule Base- Fuzzy inference system-Fuzzy decision making-Fuzzy logic controller (Block Diagram)- Application of FLC system	**7**	**15**
SECOND INTERNAL TEST		

MODULE 5 **Fundamentals of genetic algorithms:** Basic concepts- working princ – encoding – different methods – fitness function – reproduction-differe methods. Genetic modelling- inheritance- Crossover mutation-converge of genetic algorithm.	**7**	**20**
MODULE 6 **Hybrid systems:** Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids-Genetic algorithm based back propagation network-Fuzzy back propagation networks. Case studies: (A group of 3 or 4 students will take up an application in one of the topics related to water resources and hydroinformatics and present this case study)	**7**	**20**

07 CE 7415: SPATIAL ANALYSIS IN WATERSHED MANAGEMENT

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre-requisites: Nil

Objective: To introduce advanced GIS technologies for watershed management

Syllabus

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

Course Outcomes:

- *Understand the basic concepts and operation of GIS for water resources Data models,*
- *Demonstrate ability to create digital data models of water resources in GIS: from existing data source*
- *Conduct hydrologic calculations using map algebra on raster grids*
- *Analyze a digital elevation model of land surface terrain to derive watersheds and stream networks*
- *Have an ability to use geospatial technologies to gain a significant advantage in the information technology field*

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, Pearson Education (Singapore) Pvt. Ltd., Delhi – 110 092, 2001
3. Mitchell A., The ESRI Guide to GIS Analysis Volume 1: Geographical Patterns and Relationships, Environmental Systems 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. VenTe 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: 40 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 two tests per subject.

iii) Two internal tests, each having 15 marks
iv) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 7415: SPATIAL ANALYSIS IN WATERSHED MANAGEMENT

(L-T-P : 3-0-0) CREDITS:3

Modules	Contact Hours	Sem. Exam marks %
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 – neighbourhood statistics – reclassification.	**7**	**15**
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.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Analysing Surfaces: Understanding the shape of a surface – calculating slope, mapping contours - deriving contour lines from a surf ace – calculating area and volume	**7**	**15**

MODULE 4 Application of GIS in water resources -Hydro networks- Flow direction-Flow Accumulation- river addressing-Drainage systems-watersheds-Drainage analysis using DEM-Watershed Delineation.	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Watershed Analysis-Flood plain delineation-River modelling-Digital Terrain Models-Time series Integrating GIS with Hydrologic Modelling- Basic elements of GIS modelling -	**7**	**20**
MODULE 6 Classification of GIS modelling- modelling process- Integration of GIS with hydraulic modelling -binary models-index models- Regression models-process models- Building of raster and vector based binary and index models	**7**	**20**

07 CE 7417: ARTIFICIAL NEURAL NETWORKS

(L-T-P: Credit): 3-0-0: 3 Year :2015

Objective:

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

Syllabus:

Introduction to Neural Networks: Biological and artificial Neurons -Neural Networks- Learning rules. LMS algorithm- Back-Propagation algorithms-Radial Basis Function Networks- Applications of Multi-layer perceptrons. 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 Applications of artificial neural networks: Application areas like system identification and control, decision making, pattern recognition, pattern mapping and sequence recognition.

Course Outcomes:

- *To understand the broad concept of artificial intelligence and artificial neural networks.*
- *To know the possible applications of artificial neural networks (ANN).*
- *To relate biological neural networks to ANN.*
- *To understand the capabilities and limitations of ANN and to Determine under which circumstances neural networks are useful in real applications*

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: 40 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 two tests per subject.

v) Two internal tests, each having 15 marks

vi) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan

07 CE 7417: ARTIFICIAL NEURAL NETWORKS **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Introduction to Neural Networks: Biological Neurons and Neural Networks, Networks of Artificial Neurons. Single Layer Perceptron, Learning and Generalization in Single Layer Perceptrons, Hebbian Learning, Gradient Descent Learning, learning rates, Widrow-Hoff Learning , The Generalized Delta Rule, Practical Consideration	**7**	**15**
MODULE 2 Basic neural network models: ADALINE networks, LMS algorithm, Learning in Multi-Layer Perceptrons, Derivation of the Back-Propagation algorithms, sigmoidal non-linearity-learning rate momentum factor. Stopping criteria. Other factors controlling the efficiency and accuracy of BPN.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 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.	**7**	**15**
MODULE 4 Basic learning models: Associative Learning, Competitive Networks, Winner-take-all networks, Adaptive Resonance Theory (ART), neural networks as associative memories, Hopfield network,	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 BAM, Self Organizing Maps: Fundamentals, Algorithms and Applicati Learning Vector Quantization, Optimization problems solving using ne networks, stochastic neural networks, Boltzmann machine	**7**	**20**
MODULE 6 Applications of artificial neural networks: Application areas like system identification and control, decision making, pattern recognition, pattern mapping and sequence recognition. Case studies: (A group of 3 or 4 students will take up an application in one of the topics related to water resources and hydroinformatics and present this case study)	**7**	**20**

07 CE 7419: IRRIGATION SYSTEM DESIGN

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Objective:

- **To** *understand the interaction between soil, water, climate and plants during irrigation.*
- Optimum design of irrigation systems

Syllabus:

Fundamental principles –development and distribution of Irrigation systems-Principles of economics analysis –predicting yield response. Principles of soil physics: Soil water potential- Infiltration and Hydraulic conductivity. Soil chemistry: Soil chemical properties and its impact on yield. Crop water Requirement-Temperature based methods- pan evaporation- combination methods crop coefficient curves Irrigation project planning. Surface system: Furrow system design- m Level basin System design - Graded border system design. Sprinkler Irrigation –components of system design. istribution system layout and design. Trickle and pipeline system design- Emitters-Lateral hydraulics . Pipeline system design – pressure distribution in pipelines

Course Outcomes:

- *comprehensive knowledge of crop water requirement and its estimations*
- *To master the principles of hydraulics and apply them to plan and design the different components of irrigation systems.*

References:

1. Richard H.Cuenca : Irrigation System Design : An Engineering Approach, Prentice Hall (1989)
2. Walkers, Guidelines for designing and evaluating surface irrigation systems FAO, Irrigation And Drainage Paper 45

Internal continuous assessment: 40 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.

v) Two internal tests, each having 15 marks

vi) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 7419: IRRIGATION SYSTEM DESIGN **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Fundamental principles –development and distribution of Irrigation systems-Principles of economics analysis –predicting yield response.	**7**	**15**
MODULE 2 Principles of soil physics: Soil water potential- Infiltration and Hydraulic conductivity. Soil chemistry: Soil chemical properties and its impact on yield	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Crop water Requirement-Temperature based methods- pan evaporation- combination methods crop coefficient curves Irrigation project planning	**7**	**15**
MODULE 4 Surface system: Furrow system design- m Level basin System design - Graded border system design	**7**	**15**
SECOND INTERNAL TES		
MODULE 5 Sprinkler Irrigation –components of system design- Distribution system layout and design.	**7**	**20**
MODULE 6 Trickle and pipeline system design- Emitters-Lateral hydraulics, Pipeline system design – pressure distribution in pipelines	**7**	**20**

07 CE 7423: ADVANCED HYDROLOGIC ANALYSIS AND DESIGN

Credits: 3-0-0: 3 Year :2015

Prerequisites: Surface Water Hydrology

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.*

Syllabus:

Hydrologic and Hydraulic Models. Classification, systems approach. concept of a model. Classification of hydrological models, Hydrologic Simulation and Stream Flow Synthesis: Classification of Hydrologic Simulation Models. Single-Event Rainfall-Runoff Models. Continuous Simulation Models. Ground water Flow Simulation Models. Stream flow Synthesis. Risk Analysis – Design Storms and its synthesis. Design Flows. Urban Storm Drainage Design, Airport Drainage Design, Detention Storage Design. Random Processes: Classification – Stationary Random process - Components of time series – Trend Analysis – Regression – Multiple Linear Regression – Diagnostic tools. 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.

Course Outcomes:

- Application of statistical models for the analysis of hydrologic variables and processes,
- *Compare methods of parameter estimation for frequency distributions in hydrology*
- *Apply multivariate analysis in hydrologic systems*
- *Analyse hydrologic time series*
- *Develop models for synthesis of hydrologic variables*

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: 40 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.

vii) Two internal tests, each having 15 marks
viii) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 7423: ADVANCED HYDROLOGIC ANALYSIS AND DESIGN **Credits: 3-0-0: 3**		
Modules	**Contact Hours**	**Sem. Exam marks %**
MODULE 1 **Hydrologic And Hydraulic Models:** Hydrologic investigation - systems approach – concept of a model. Classification of hydrological models. Lumped and distributed, empirical, process based, black box model	**7**	**15**
MODULE 2 Chow-Kulandaiswamy model. Time-area methods –Unit Hydrograph – Instantaneous Unit Hydrograph. – Synthetic Unit Hydrographs. Clark model, Nash model, Tank model.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 **Hydrologic Simulation and Stream Flow Synthesis:** Classification of Hydrologic Simulation Models. Single-Event Rainfall-Runoff Models. Continuous Simulation Models. Ground water Flow Simulation Models. Stream flow Synthesis.	**7**	**15**
MODULE 4 Risk Analysis – Design Storms and its synthesis. Design Flows. Urban Storm Drainage Design, Airport Drainage Design, Detention Storage Design.	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 **Random Processes:** Classification – Stationary Random process - Components of time series – Trend Analysis – Regression – Multiple Linear Regression – Diagnostic tools.	**7**	**20**
MODULE 6 **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.	**7**	**20**

07 CE 7111 PLANNING AND DESIGN OF ENVIRONMENTAL FACILITIES

(L-T-P : 3-0-0) CREDITS: 3 Year: 2015

Pre Requisites: Water supply engg, basic water chemistry and wastewater engg

Course Objectives:

- Students are expected to know in detail the various water and wastewater treatment systems and their layout and design.
- To successfully educate the students with a firm foundation related to environmental planning and design
- To equip them to think about a green and clean technology
- Exploring computer-based design tools for advanced water treatment purification process and wastewater reuse and desalination

Syllabus

Environmental Engineering hydraulic design: Water distribution systems- Design of distribution systems- Distribution system components – Analysis of networks– Computer Programmes. Types of sewerage system – Design of various sewer appurtenances - Structural requirement of sewer under various conditions. Roadways and Airport drainage -- Pumps – Design of water treatment units – sedimentation tanks, Mixing basins, Flash Mixer, Clariflocculator, Slow sand filter, Rapid sand filter, Spray and Cascade aerator, Chlorinator. Design of waste water treatment units – screens, Grit chamber, Sedimentation tank, Activated sludge process. Trickling filter, Aerated lagoons, Stabilization ponds, Oxidation ditch, Septic tank, Inhoff tank, Sequencing batch reactor, Sludge digestion tank.

Course Outcomes:

- Provides a comprehensive knowledge of the fundamental principles and practices in water and wastewater processing, distribution, collection and treatment
- To make them capable of avoiding or minimizing the production of wastes through technological changes and suggest design alternatives.

Text books:

1. Metcalf and Eddy Inc. - Waste water Engineering: Treatment, disposal & reuse,Tata Mc Graw Hill

References:

1. Peavy- Environmental Engineering, McGraw Hill
2. Rodger Walker- Water supply Treatment and distribution
3. Sincero- Environmental Engineering: A Design Approach, Prentice Hall of India, Delhi
4. Wilson- Design calculations in waste water treatment, McGraw Hill Kogakusha
5. Sharma, H.D. and Lewis, S.P, Waste Containment systems, Waste stabilization and Landfills: Design and evaluation, John Wiley & sons Inc., 1994

Internal continuous assessment: 40 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.

ix) Two internal tests, each having 15 marks

x) Tutorials/Assignments having 10 marks

End semester Examination: 60 marks

Course Plan:

07 CE 7111 PLANNING AND DESIGN OF ENVIRONMENTAL FACILITIES **(L-T-P : 3-0-0) CREDITS:3**		
Modules	**Contact Hours**	**Sem. Exam Marks %**
MODULE 1 Types of sewerage system – Hydraulics of sewers –Design of various sewer appurtenances - Design of sanitary and storm water sewers – Structural requirement of sewer under various conditions.	**6**	**15**
MODULE 2 Types of sewerage system – Hydraulics of sewers –Design of various sewer appurtenances - Design of sanitary and storm water sewers – Structural requirement of sewer under various conditions.	**7**	**15**
FIRST INTERNAL TEST		
MODULE 3 Design of surface and subsurface drainage – Roadways and Airport drainage -- Pumps – Design of water and waste water pumping system	**6**	**15**
MODULE 4 Design of water treatment units – Design of sedimentation tanks, Mixing basins, Flash Mixer, Clariflocculator, Slow sand filter, Rapid sand filter, Spray and Cascade aerator, Chlorinator	**7**	**15**
SECOND INTERNAL TEST		
MODULE 5 Design of waste water treatment units – Design of screens, Grit chamber, Sedimentation tank, Activated sludge process	**8**	**20**
MODULE 6 Trickling filter, Aerated lagoons, Stabilization ponds, Oxidation ditch, Septic tank, Inhoff tank, Sequencing batch reactor, Sludge digestion ta	**8**	**20**

07 CE 7401: SEMINAR

(L-T-P : 0-2-0) CREDITS: 2 Year: 2015

Objective:

To assess the debating capability of the student to present a technical topic.

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.

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. The seminar shall be of 30 minutes. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. 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 department library.

A committee constituted within the department shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee/students.

Course outcome :

- To face the audience with confidence and self esteem
- To have Debating capability and presentation skills in a technical topic of his interest.
- Develop the knowledge about contemporary issues and research opportunities
- To communicate effectively and professionally in both verbal and written forms
- Capability for self education and lifelong learning

Internal continuous assessment: 100 marks

Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar. Distribution of marks for the seminar is as follows.

Marks for the report:	30%
Presentation:	40%
Ability to answer questions on the topic	30%

07 CE 7403: PROJECT PHASE 1

Credits: 6

Hours per week: 12

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 given in 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 4^{th} 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.

Course Outcomes

- Knowledge about contemporary issues and research opportunities
- Apply the acquired Mathematical /Engineering knowledge to a practical situation and thereby develop critical analysis and Problem solving skill so as to Design and develop engineering solutions
- Identify the method of investigations and conduct of the same for evolving solutions to complex engineering problems by effective use of necessary computational tools
- Interact with the society effectively for finding pressing problems and for extracting necessary data to evolve their solution

- Gain right outlook to maintain professional code of practice and ethics and sustainable perspective for designing environment friendly development programmes for the society
- Communicate effectively with peers and society
- Get hankering for Lifelong learning.

Internal assessment

The Evaluation committee consists of at least three faculty members of which internal guide and another expert. Project work is to be evaluated both in the third and the fourth semesters. Based on these evaluations the grade is finalised in the fourth semester. The final evaluation of the project will be taken up only after the students earn all the credits listed in first to third semester.

Total marks in the 3rd Semester: - Marks: 50

Project Progress evaluation:

Progress evaluation by the Project Supervisor : 20 Marks

Presentation and evaluation by the committee : 30 Marks

SEMESTER 4

07 CE 7404: PROJECT PHASE 2

Credits: 12

Hours per week: 21

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.***

General Outline and evaluation

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. Final evaluation of the project will be taken up only on completion of the project in the fourth semester. This shall be done by a committee constituted for the purpose by the principal of the college.

Final evaluation of the project will be taken up only if the student has earned all course credits listed in the first three semesters. Project evaluation shall be done by the same committee mentioned above with an external expert, either from an academic/R&D organization or from Industry, as an additional member. Final project grading shall take into account the progress evaluation done in the third semester and the project evaluation in the fourth semester. If the quantum of work done by the candidate is found to be unsatisfactory, the committee may extend the duration of the project up to one more semester, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project.

Course Outcome

- Knowledge about contemporary issues and research opportunities
- Apply the acquired Mathematical /Engineering knowledge to a practical situation and thereby develop critical analysis and Problem solving skill so as to Design and develop engineering solutions
- Identify the method of investigations and conduct of the same for evolving solutions to complex engineering problems by Effective use of necessary computational tools
- Interact with the society effectively for finding pressing problems and for extracting necessary data to evolve their solution
- Gain right outlook to maintain professional code of practice and ethics and sustainable perspective for designing environment friendly development programmes for the society
- To build up enough confidence in taking up the challenges in solving engineering problems
- Communicate effectively with peers and society
- Critically evaluate financial viability and implementation feasibility of various engineering solutions
- Get hankering for Lifelong learning.

Internal Continuous Assessment

Total marks in the 4th Semester: -	100 marks
Project evaluation by the supervisor/s	: 30 Marks
Presentation & evaluation by the Committee	: 40 Marks
Evaluation by the External expert	: 30 Marks