

## **DEPARTMENT OF CIVIL ENGINEERING**

### **DEPARTMENT PROFILE**

The Department of Civil Engineering established in 1945, presently offers Under Graduate Programme in B.E. (Civil Engineering), Post Graduate Programmes in Water Resources Engineering & Management and Environmental Engineering and Ph.D. in Civil Engineering. The Department has strong faculties having professional affiliation in various organizations. It has produced more than 20 Ph.D.'s for the past 10 years and about 30 Ph.D.'s are on going which has mooted research in areas such as Surface and Groundwater development, Operation and management of Irrigation systems, Climate change and its impacts, Application of soft computing techniques, Spatial Modeling using RS & GIS, Wastewater Treatment, Air Pollution Monitoring and Modeling and Solid waste Management. These aspects have placed the Department as UGC-SAP-DRS (Level-I) from 2009-2014. It is well equipped with Hydraulic, Environmental, Computer & Survey Laboratories. Under UGC, UGC- SAP, AICTE, and other funding agencies, the Department has received grants under major and minor projects worth about Rs.2.25crores. The Centre for Environment, Health & Safety (CEHS), an integral part of Department of Civil Engineering, accredited by NABET carries research, consultancy and training in thrust areas of Environmental Engineering and has completed industrial consultancy works worth about Rs. 1 crore in the last three years and currently pursuing works for another Rs 50 lakhs. The Department has MoU /Collaborations for students Exchange programmes with University of Fukui, Japan.

**1. Staff List (with qualification / specification / passport size Photo)**

S.No	Name	Designation	Qualification	Specialization	Photo
1	Dr. A. MURUGAPPAN	PROF. & HEAD	Ph.D.	Water Resources Engg. & Mgt.	
2	Dr.V.ARUTCHELVAN	PROFESSOR	Ph.D.	Environmental Engineering	
3	Dr.V.NEHRUKUMAR	PROFESSOR	Ph.D.	Environmental Engg.	
4	Dr.S.POONGOTHAI	PROFESSOR	Ph.D.	Water Resources Engineering	
5	Dr..N.MANIKUMARI	PROFESSOR	Ph.D.	Water Resources Engineering	
6	Dr. M. RAJENDRAN	PROFESSOR	Ph.D	Environmental Engineering	
7	Dr.S.PALANIVELRAJA	PROFESSOR	Ph.D.	Air Quality Modeling	
8	Mr.T.RAMESH	ASSOCIATE PROFESSOR	M.E.	Structural Engg., & Environmental. Engg.	

9	Mr.S.BALAKUMAR	ASSOCIATE PROFESSOR	M.E.	Environmental Engineering	
10	Dr.S.MOHAN	ASSOCIATE PROFESSOR	Ph.D.	Environmental Engineering	
11	Mr.S.GNANAKUMAR	ASSOCIATE PROFESSOR	M.E.	Environmental Engineering	
12	Mr.S.RAJARATHINAM	ASSOCIATE PROFESSOR	M.E.	Transportation Engg .	
13	Mr.A.MANOCHARAN	READER	M.E.	Architecture & Urban& Rural Planning	
14	Mr.G.SENTHILKUMAR	ASSISTANT PROFESSOR	ME.	Hydraulic M/c Fluid Mechanics	
15	Dr.C.JODHI	ASSISTANT PROFESSOR	Ph.D.	Environmental Engineering	
16	Mr.N.NAGARAJAN	ASSISTANT PROFESSOR	M.E.	Irrigation Engineering	
17	Dr.B.ASHA	ASSISTANT PROFESSOR	Ph.D.	Structural Engineering & Environmental Engineering	

18	Dr.B.KUMARAVEL	ASSISTANT PROFESSOR	Ph.D.	Water Resources Engg. & Mgmt	
19	Mr.K.KARTHIKEYAN	ASSISTANT PROFESSOR	M.E	Water Resources Engg. & Mgmt	
20	Mr.S.SIVAPRAKASAM	ASSISTANT PROFESSOR	M.E	Water Resources Engg. & Mgmt	
21	Ms.K.EZHISAI VALLABI	ASSISTANT PROFESSOR	M.E	Water Resources Engg. & Mgmt	
22	Mr.G.KANNAN	ASSISTANT PROFESSOR	M.E	Water Resources Engg. & Mgmt	
23	Mr.T.VELAYUTHAM	ASSISTANT PROFESSOR	M.E	Water Resources Engg. & Mgmt	
24	Dr.V.DAMODHARAN	ASSISTANT PROFESSOR	Ph.D.	Environmental Engineering	
25	Mr.N.ASHOKKUMAR	ASSISTANT PROFESSOR	M.E	Water Resources Engg. & Mgmt	
26	Mr.R.MATHIYAZHAGAN	ASSISTANT PROFESSOR	M.E	Water Resources Engg. & Mgmt	

27	Dr.P.SIVARAJAN	ASSISTANT PROFESSOR	Ph.D.	Water Resources Engg.& Mgmt & Environmental Engineering	
28	Ms.R.SHEELA	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
29	Mrs.M.LATHA	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	
30	Mr.N. RAVISHANKAR	ASSISTANT PROFESSOR	M.E	Irrigation Engineering	
31	Mr.P.S.SARAVANA NATARAJAN	ASSISTANT PROFESSOR	M.E.	Environmental Engineering	
32	Mr.P.RAVI CHANDRAN	ASSISTANT PROFESSOR	M.E.	Environmental Engineering	
33	Mr.S.SYED ENAYATHALI	ASSISTANT PROFESSOR	M.E	Industrial Safety Engg.	
34	Mrs.T.INBANILA	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
35	Mr. K.R. VENKATESH	ASSISTANT PROFESSOR	M.E	Environmental Engineering	

36	Mr.K.BALAJI	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
37	Mr.P.SIVAGURU	ASSISTANT PROFESSOR	M.E.	Environmental Engineering	
38	Mr.S.SANKARAN	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
39	Mr.T.VENKATARAMAN	ASSISTANT PROFESSOR	M.E.	Environmental Engineering	
40	Mr.T.KAVIMANI	ASSISTANT PROFESSOR	M.E.	Environmental Engineering	
41	Mr.PL.SENTHIL KUMAR	ASSISTANT PROFESSOR	M.E.	Environmental Engineering	
42	Mr. C.VENGATACHALAPATHY	ASSISTANT PROFESSOR	M.E.	Environmental Engineering	
43	Mr.S.SIVAPRAKASAM	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
44	Mr.M.VELAYUDHA DAS	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	
45	Mr.J.MOHAMED ASHIK ALI	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	

					
46	Mr.T. POONKUNDRAN	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	
47	Mrs.A.BHUVANESWARI	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
48	Mrs.S.DEVI	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
49	Mr.U.K.ENIYON	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
50	Mr.G.NEELAGANDAN	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	
51	Mr. R.M. BALAGURU	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	
52	Mrs.G.SIVAGAMASUNDARI	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	
53	Mr. M. IYYAPPAN	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	
54	Ms. N. SILAMBARASI	ASSISTANT PROFESSOR	M.E	Environmental Engineering	
55	Mr. R.S. SARAVANAN	ASSISTANT PROFESSOR	M.E	Water Resources Engg.& Mgmt	

## II. Student Enrolment

Academic year	Programme	Student Enrolment					
		Home State	Other State	Male	Female	SC	ST
2007-2008	B.E (Civil)	194	5	180	19	121	1
2008-2009		477	134	544	67	249	9
2009-2010		612	149	696	65	371	22
2010-2011		636	236	794	78	429	31
2011-2012		543	232	721	54	394	43

### M.E (Environmental Engineering)

Academic year	Programme	Student Enrolment					
		Home State	Other State	Male	Female	SC	ST
2007-2008	M.E	2	-	1	1	-	-
2008-2009		-					
2009-2010		2		1	1	-	-
2010-2011		5	1	2	4	2	-
2011-2012		5	1	4	2	1	-

### M.E (Water Resources Engineering and Mgt)

Academic year	Programme	Student Enrolment					
		Home State	Other State	Male	Female	SC	ST
2007-2008	M.E	-	-				
2008-2009		8	-	8	-	-	-
2009-2010		7	-	6	1	1	
2010-2011		-	-				
2011-2012		-	-				



**III. Academic collaboration (if any): NIL**

**XII. Extension Activity: NIL**

**IV. Syllabus / Model question paper (each paper):**

**BACHELOR OF ENGINEERING (CIVIL)  
4 YEAR DEGREE PROGRAMME**

**ANNAMALAI UNIVERSITY  
ANNAMALAINAGAR**



**H A N D B O O K**  
**(Regulations and Syllabi)**

**Bachelor of Engineering (Civil)**  
**Choice Based Credit System (CBCS)**

**COURSES OF STUDY AND SCHEME OF EXAMINATIONS**

**BACHELOR OF ENGINEERING (CIVIL) – FULL-TIME  
(4 Year Degree Programme)  
CHOICE BASED CREDIT SYSTEM (CBCS)**

**FIRST YEAR**

Course Code	Course	Periods of Instructions per week				Duration of exam Hrs.	Marks			Credits
		L	T	P	D		Sess.	Exam	Total	
101	Technical English	3	--	--	--	3	25	75	100	3
102	Engineering Mathematics-I	3	1	--	--	3	25	75	100	4
103	Engineering Physics	3	--	--	--	3	25	75	100	3
104	Engineering Chemistry	3	--	--	--	3	25	75	100	3
105	Engineering Mechanics	3	--	--	--	3	25	75	100	3
106	Basic Engineering (Civil, Mechanical & Electrical)	6	--	--	--	3	25	75	100	3
107	Environmental Studies	3	--	--	--	3	25	75	100	3
108	Engineering Drawing	--	--	--	3	3	40	60	100	2
109	Physics Laboratory	--	--	3	--	3	40	60	100	2
110	Chemistry Laboratory	--	--	3	--	3	40	60	100	2
111	Computer Programming	1	--	2	--	3	40	60	100	2
112	Workshop Practice	--	--	3	--	3	40	60	100	2
	<b>Total</b>	<b>25</b>	<b>1</b>	<b>11</b>	<b>3</b>		<b>375</b>	<b>825</b>	<b>1200</b>	<b>32</b>

**Cumulative: 32**

L – Lecture    T – Tutorial    P – Practical    D – Drawing

### III SEMESTER

CODE	COURSE	INS./WEEK IN HOURS				DURATION OF EXAM (HOURS)	MARKS		TOTAL	CREDIT UNITS
		L	T	P	D		EXAM	SESS		
CLEC301	Engineering Mathematics-II	4	1	-	-	3	75	25	100	4
CLEC302	Mechanics Of Solids - I	4	2	-	-	3	75	25	100	4
CLEC303	Construction Engineering	4	-	-	-	3	75	25	100	4
CLEC304	Engineering Geology	4	-	-	-	3	75	25	100	4
CLEC305	Concrete Technology	4	-	-	-	3	75	25	100	4
CLEC306	Fluid Mechanics	4	1	-	-	3	75	25	100	4
CLEC307	Construction Laboratory	-	-	4	-	3	60	40	100	2
CLEC308	Computer Aided Building Drawing	-	-	4	-	3	60	40	100	2
<b>Total</b>		<b>24</b>	<b>4</b>	<b>8</b>	<b>-</b>	<b>24</b>	<b>570</b>	<b>230</b>	<b>800</b>	<b>28</b>

L – Lecture, T – Tutorial, P – Practical, D- Drawing

## IV SEMESTER

CODE	COURSE	INS./WEEK IN HOURS				DURATION OF EXAM (HOURS)	MARKS		TOTAL	CREDIT UNITS
		L	T	P	D		EXAM	SESS		
CLEC401	Engineering Mathematics-III	4	1	-	-	3	75	25	100	4
CLEC402	Surveying-I	4	-	-	-	3	75	25	100	4
CLEC403	Mechanics Of Solids-II	4	2	-	-	3	75	25	100	4
CLEC404	Structural Engineering-I	4	-	-	-	3	75	25	100	4
CLEC405	Estimation & Valuation	4	-	-	-	3	75	25	100	4
CLEC406	Transportation Engineering-I	4	-	-	-	3	75	25	100	4
CLEC407	S.M.Laboratory	-	-	4	-	3	60	40	100	2
CLEC408	Survey Laboratory	-	-	4	-	3	60	40	100	2
<b>Total</b>		<b>24</b>	<b>3</b>	<b>8</b>	<b>-</b>	<b>24</b>	<b>570</b>	<b>230</b>	<b>800</b>	<b>28</b>

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## V SEMESTER

CODE	COURSE	INS./WEEK				DURATION OF EXAM (HOURS)	MARKS		TOTAL	CREDIT UNITS
		L	T	P	D		EXAM	SESS		
CLEC501	Numerical Methods	4	1	-	-	3	75	25	100	4
CLEC502	Surveying – II	4	-	-	-	3	75	25	100	4
CLEC503	Structural Mechanics-I	4	2	-	-	3	75	25	100	4
CLEC504	Soil Mechanics	4	-	-	-	3	75	25	100	4
CLEC505	Structural Engineering-II	4	-	-	-	3	75	25	100	4
CLEC506	Transportation Engineering-II	4	-	-	-	3	75	25	100	4
CLEC507	Survey Laboratory-II	-	-	4	-	3	60	40	100	2
CLEC508	Computer Aided Design and Drawing Practical-I	-	-	4	-	3	60	40	100	2
<b>Total</b>		<b>24</b>	<b>3</b>	<b>8</b>	<b>-</b>	<b>24</b>	<b>570</b>	<b>230</b>	<b>800</b>	<b>28</b>

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## VI SEMESTER

CODE	COURSE	INS./WEEK IN HOURS				DURATION OF EXAM (HOURS)	MARKS		TOTAL	CREDIT UNITS
		L	T	P	D		EXAM	SESS		
CLEC601	Hydrology	4	1	-	-	3	75	25	100	4
CLEC602	Hydraulics and Hydraulic Machinery	4	1	-	-	3	75	25	100	4
CLEC603	Structural Mechanics-II	4	1	-	-	3	75	25	100	4
CLEC604	Foundation Engg.	4	-	-	-	3	75	25	100	4
CLEC605	Environmental Engineering-I	4	-	-	-	3	75	25	100	4
CLEC606	Construction Techniques and Management	4	-	-	-	3	75	25	100	4
CLEC607	Fluid Mechanics and Machines Lab	-	-	4	-	3	60	40	100	2
CLEC608	Soil Mechanics Laboratory	-	-	4	-	3	60	40	100	2
<b>TOTAL</b>		<b>24</b>	<b>3</b>	<b>8</b>	<b>-</b>	<b>24</b>	<b>570</b>	<b>230</b>	<b>800</b>	<b>28</b>

L – Lecture, T – Tutorial, P – Practical, D- Drawing

## VII SEMESTER

CODE	COURSE	INS./WEEK IN HOURS				DURATION OF EXAM (HOURS)	MARKS		TOTAL	CREDIT UNITS
		L	T	P	D		EXAM	SESS		
CLEC701	Ground Water Engineering	4	-	-	-	3	75	25	100	4
CLEC702	Irrigation and Water Power Engineering	4	-	-	-	3	75	25	100	4
CLEC703	Environmental Engineering-II	4	-	-	-	3	75	25	100	4
CLEC704	Remote Sensing and GIS	4	-	-	-	3	75	25	100	4
CLEC705	Elective-I	4	-	-	-	3	75	25	100	4
CLEC706	Elective-II	4	-	-	-	3	75	25	100	4
CLEC707	Environmental Laboratory	-	-	4	-	3	60	40	100	2
CLEC708	Computer Design & Drawing Practical - II Seminar	-	-	4	-	3	60	40	100	2
		-	2	-	-					
<b>Total</b>		<b>24</b>	<b>2</b>	<b>8</b>	<b>-</b>	<b>24</b>	<b>570</b>	<b>230</b>	<b>800</b>	<b>28</b>

L – Lecture, T – Tutorial, P – Practical, D- Drawing



## VIII SEMESTER

CODE	COURSE	INS./WEEK IN HOURS				DURATION OF EXAM (HOURS)	MARKS		TOTAL	CREDIT UNITS
		L	T	P	D		EXAM	SESS		
CLEC801	Prestressed Concrete	4	-	-	-	3	75	25	100	4
CLEC802	Maintenance & Rehabilitation of Structures	4	-	-	-	3	75	25	100	4
CLEC803	Interior Decoration and Planning	4	-	-	-	3	75	25	100	4
CLEC804	Ethics in Engineering	2	-	-	-	3	75	25	100	2
CLEC805	Elective-III	4	-	-	-	3	75	25	100	4
CLEC806	Elective-IV	4	-	-	-	3	75	25	100	4
CLEC807	Project Seminar	-	-	4	-		60	40	100	6
<b>Total</b>		<b>22</b>	<b>2</b>	<b>4</b>	<b>-</b>	<b>18</b>	<b>510</b>	<b>190</b>	<b>700</b>	<b>28</b>

L – Lecture, T – Tutorial, P – Practical, D- Drawing

## **List of Electives (Appendix – I)**

1. Urban and Rural Planning
2. Drainage and Flood Control Engineering
3. Industrial Waste Treatment and Disposal
4. Civil Engineering Systems Analysis and Design
5. Advanced Hydrology
6. Architecture
7. Prefabricated & Industrial Structures
8. Services in High-rise Buildings
9. Watershed Conservation and Management
10. Water Resources Systems Management
11. Solid waste and Hazardous Waste Management
12. Earth Quake Engineering
13. Hydro Power Engineering
14. Environmental Impact Assessment
15. Management Science
16. Economics and Finance for Civil Engineers
17. Entrepreneurship

### **III SEMESTER**

#### **CLEC301 - ENGINEERING MATHEMATICS-II**

##### **AIM**

The course aims to develop the skills of the students in the areas of boundary value problems and transform techniques. This will be necessary for their effective studies in a large number of engineering subjects like heat conduction, communication systems, electro-optics and electromagnetic theory. The course will also serve as a prerequisite for post graduate and specialized studies and research.

##### **OBJECTIVES**

At the end of the course the students would,

- Be capable of mathematically formulating certain practical problems in terms of partial differential equations, solve them and physically interpret the results.
- Have gained a well founded knowledge of Fourier Series, their different possible forms and the frequently needed practical Fourier analysis that an engineer may have to make from discrete data.
- Have obtained capacity to formulate and identify certain boundary value problems encountered in engineering practices, decide on applicability of the Fourier series method of solution. Solve them and interpret the results.
- Have grasped the concept of expression of a function, under certain conditions as a double integral leading to identification of transform pair, and specialization on Fourier transform pair, their properties, the possible special cases with attention to their applications.
- Have learnt the basics of Z - transform in its applicability to discretely varying functions, gained the skill to formulate certain problems in terms of difference equations and solve them using the Z - transform technique bringing out the elegance of the procedure involved.

##### **UNIT - I PARTIAL DIFFERENTIAL EQUATIONS**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second order with constant coefficients.

## **UNIT - II   FOURIER SERIES**

Dirichlet's conditions – General Fourier Series – odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity.

## **UNIT - III   BOUNDARY VALUE PROBLEMS**

Solutions of one dimensional wave equation – One dimensional heat equation (without derivation). Fourier series solutions in Cartesian co-ordinates.

## **UNIT - IV   FOURIER TRANSFORM**

Fourier integral theorem (without proof) – Fourier transform pair – Sine and cosine transforms – Properties – Transforms of simple functions – convolution theorem – Parseval's identity.

## **UNIT - V   Z-TRANSFORM AND DIFFERENCE EQUATIONS**

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Solution of difference equations using Z-transform.

### **TEXT BOOKS:**

1. Engineering Mathematics series - Kandasamy.P, Thilagavathy.K and Gunavathy.K, S.Chand & Co. Ltd., New Delhi, 2004.
2. Engineering Mathematics series - Venkatraman.M.K. The National Publishing Co., Chennai, 2003.
3. Transform and Partial Differential Equations – Vairamanickam. K, Nirmala P. Ratchagar, and Tamilselvan. S, Scitech Publications, Chennai, 2009.

### **REFERENCE BOOKS:**

1. Engineering Mathematics series - Veerarajan.T, Tata McGraw. Hill Publishing Co., Ltd., New Delhi, 2002.
2. Engineering Mathematics series - Singaravelu.A, Meenakshi Publications, Chennai, 2004.
3. Advanced Engineering Mathematics - Wylie.C., Ray and Barrett Louis.C., McGraw-Hill Inc., New York.

## **CLEC 302 MECHANICS OF SOLIDS - I**

### **Objective**

This course is one of the core courses in Civil and Structural Engineering. The fundamental principles operating on development of stresses and deformations of solid bodies due to various loading patterns is covered in this course. This is a compulsory course for all engineers as well as architects.

### **UNIT - I**

Simple Stresses and Strains - Hookes Law - Principle of superposition - Composite Sections - Temperature Stresses - Hoop Stresses - Elastic Constants Principal Stresses and Strains - Mohrs Circle - Strain Energy and Impact loading - Stresses due to gradual, sudden and impact loading - Proof resilience - Shear resilience.

### **UNIT - II**

Geometrical properties of Sections - Centroid - Centre of mass Centre of gravity - Moment of inertia - Area moment of inertia - Mass moment of inertia - Rectangular moment of inertia - Polar moment of inertia - Radius of gyration of an area - Perpendicular axis theorem - Parallel axis theorem - Moment of inertia of Composite and Hollow sections - Product of inertia - Principal moment of inertia.

### **UNIT - III**

Shear force and Bending moment - Types of beams - Types of loads - Relation between B.M. and S.F. - B.M.D. and S.F.D. for Cantilever beams, Simply Supported beams and Overhanging beams subjected to various types of loading - Bending Stresses in beams- Shearing Stresses in beams.

### **UNIT - IV**

Deflection of beams - Slope and Deflection at a point - Macaulays method - Mohrs theorem - Strain energy method -Estimation of Slope and Deflection for Cantilever, Simply Supported and Overhanging beams subjected to various types of loading.

### **UNIT - V**

Torsion of shafts - Assumptions - Horse power transmitted by a shaft - Strength of a shaft - Torsional resistance of Solid and Hollow shafts - Combined bending and torsion - Torsional strain energy.

Springs - Leaf springs - Helical springs - Strain energy stored in a spring.

**Text Books:**

1. **Dr.R.K.Bansal**, *Strength of Materials*, Lakshmi Publications, December 2005.
2. **R.K.Rajput**, *Strength of Materials*, S.Chand & Co., September 2000.

**Reference Books:**

1. **Dr.B.C.Punmia, et al** , *Strength of Materials and Theory of Structures - Vol.I*, Lakshmi Publications, 2000.
2. **Dr.Sadhu Singh**, *Strength of Materials*, Khanna Publishers, 1988.
3. **S.Ramamrutham**, *Strength of Materials*, Dhanpat Rai son, 1992.
4. **G.K.Hiraskar**, *Strength of Materials*. -

## **CLEC303 - CONSTRUCTION ENGINEERING**

### **Objective**

To expose the students to construction practice through an understanding of different construction materials and their properties, different types of structures and their construction, different finishing works and remedial practices for distressed structures.

### **UNIT-I**

Construction Materials : Stones- Bricks- Timber- Steel, Lime- Cement- Sand- Properties- I.S Specification for use in Construction.

### **UNIT-II**

Substructure: Type of soils- bearing capacity, Types of foundations - Principles in design, masonry-types.

### **UNIT-III**

Superstructure: Types of Roofs- Pitched and flat –Types of Stairs, Types of doors and Windows- R.C.C Works: Lintels, Beams, Slabs and Columns- shuttering, bending, placing of bars and concrete – Termite proofing- Damp Proofing.

### **UNIT-IV**

Finishing works: Plastering, Painting, Pointing, Distempering and White washing- Types of floor finishing – Formworks - Scaffoldings-Shoring - Underpinning.

### **UNIT-V**

Distress in concrete structures – Causes – Preventive measures – Repairing techniques – Strengthening methods.

Demolition Techniques for Civil Engineering Structures.

### **TEXT BOOKS:**

1. Construction Engineering - Dr.B.C.Punmia : Laxmi Publishers Pvt., Ltd., New Delhi,2002.
2. A Text Book of Building Construction Technology (Including Engineering Materials) - S.P.Arora : Dhanpat Rai Publications (P) Ltd., New Delhi,1997.

### **REFERENCE BOOKS:**

1. Building Construction – S.C.Rangwala, Charotar Publishing House, Anand-388 001, 2004.
2. ACI Manual – Parts 2 & 4, 1996.

## **CLEC304 - ENGINEERING GEOLOGY**

### **Objective**

The objective of this course is to study the properties of various minerals, different types of rocks and its geological formation, causes and effects of earthquakes, landslides and hydrogeology.

### **UNIT -1 MINERALOGY**

Definition of mineral. Physical properties of minerals. Physical properties of important rock forming minerals - quartz, feldspar, mica, pyroxene, amphibole, olivine, garnet, epidote and beryl.

## **UNIT -2 PETROLOGY**

Rocks and its classification. Mode of formation of igneous rocks. Chief forms of igneous bodies. Structures and textures of igneous rocks. Description of important igneous rocks: granite, syenite, diorite, obsidian, pumice trachyte and basalt.

Sedimentary rocks – mode of formation and classification. Description of important sedimentary rocks: sandstone, shale, limestone and laterite. Metamorphic rocks – mode of formation - important types.

## **UNIT - 3 STRUCTURAL GEOLOGY**

Dip and strike, folds, faults, joints, unconformities, overlap, outlier and inlier.

## **UNIT - 4 PHYSICAL GEOLOGY**

Earthquake – causes, effects, intensity, magnitude and distribution. Seismograph and seismogram. Seismic zones of India.

Landslides – different types, causes and prevention of landslides.

## **UNIT- 5 HYDROGEOLOGY AND ENGINEERING GEOLOGY**

Hydrological cycle. Origin and occurrence of groundwater. Vertical distribution of groundwater. Hydrogeological properties of rocks – porosity, permeability, aquifer and its types, aquifuge, aquiclude and aquitard.

Dams – definition and terminology, types of dams, geological considerations in construction of dams and reservoirs. Tunnels and types. Geological investigations related to tunnel alignments.

## **TEXT BOOKS**

1. Parbin Singh. Engineering and general geology, S.K.Kataria and sons, Delhi.
2. R.S. Khurumi. Fundamentals of Engineering geology, Tata McGraw Hill Book Co.

## **REFERENCE BOOKS**

1. A.C.Mclean & C.D. Gribble. Geology for civil engineers
2. H.F.Legget. Geology and Engineering. McGraw Hill Book Co.



# **CLEC305 - CONCRETE TECHNOLOGY**

## **Objective**

The objective of this course deals with the nature and properties of the ingredients of concrete and testing procedures of fresh and hardened concrete in addition to principles of mix design.

## **UNIT-I**

Portland cement – composition – hydration of Portland cement – hardening of cement paste - testing of cement - specifications as per IS. Code – types of Portland cement.

## **UNIT-II**

Aggregates - natural and mineral aggregates - characteristics of aggregates and their significance - testing of aggregates as per IS Code - specifications as per IS Code -water – testing- specifications.

## **UNIT-III**

Concrete - ingredients - concrete manufacturing - transporting - placing -finishing - properties of fresh concrete - workability - testing methods - segregation -bleeding - shrinkage - slump loss - concrete at early age - setting time.

## **UNIT-IV**

Hardened concrete - properties and their significance - testing methods as per IS. Code -compressive strength and factors affecting it -drying shrinkage and creep - durability of concrete - significance - causes of concrete deterioration - testing methods to assess concrete durability - non-destructive testing methods - concrete admixture - mineral admixture - chemical admixture - special concretes.

## **UNIT-V**

Concept of concrete mix proportioning - methods of mix proportioning - IS. Code method - ACI method - control of concrete quality.

## **TEXT BOOKS:**

1. Concrete, Microstructure, properties and Materials - Mehta and Montreio, P.J.M., Indian Concrete Institute, 1997.
2. Concrete Technology - Shetty, M.S., S. Chand & Co., New Delhi, 2002.
3. Shetty, M.S., Concrete Technology Theory and Practice, S. Chand & Co., New Delhi, 2006.
4. Concrete Technology - B.L.Gupta and Amit Gupta., Standard Publisher Distributors, Delhi, 2004.

## **REFERENCE BOOKS:**

1. Properties of Concrete- Neville, A.M., Pitman Publishing Limited, London ..
2. Concrete Technology - Gambhir, M.L., Tata McGraw Hill Co., New Delhi, 2005.

# CLEC306 - FLUID MECHANICS

## Objective

To introduce the mechanics of fluids through a thorough understanding of the properties of the fluids, behaviour of fluids under static conditions. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy. The applications of the conservation of laws to flow measurements, flow through pipes, flow through open channels is studied.

## UNIT-I

Fluid properties: Density-Specific weight - Specific volume-Specific gravity-Viscosity - Compressibility-ideal and real fluid-Capillarity –Surface tension.

## UNIT-II

Statics of fluid: Pressure at a point-Pressure measurement-manometers and pressure gauges-total pressure and centre of pressure–buoyancy-equilibrium of floating bodies-metacentre.

## UNIT-III

Kinematics and Dynamics: Steady and unsteady motion-path and stream lines-rotational and irrotational motion-equation of continuity-velocity–potential and stream function–local, convective and total accelerations-Euler’s equation along a stream line–Bernoulli’s equation for steady flow-flow in a curved path-free and forced vortex flow.

## UNIT-IV

Flow of incompressible fluid in pipes: Laminar and turbulent flow-Reynolds’s number-Pressure losses in pipes flowing in closed conduits-Hydraulic gradient-energy gradient-laminar flow in circular pipes-Turbulent flows in circular pipes-elementary concept of boundary layer-velocity distribution in circular pipes-losses at entrance due to enlargement and contraction-flow between two reservoirs-size of pipe for a given discharge-pipes in series and parallel-transmission of power.

## UNIT-V

Flow in open channels: Types of flow-Uniform flow equations for flow-Chezy’s formula –Manning’s formula-velocity distribution –most efficient cross section –circular cross—section not flowing full-Total head and specific energy-critical depth and critical velocity-sub critical flow –hydraulic jump-measurements by notches- pitot tube and current meters.

## TEXT BOOKS:

1. Fluid Mechanics (Including Hydraulic Machines), Dr.A.K.Jain, Khanna Publishers, Delhi, 2005.
2. A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines, R.S.Khurmi, S.Chand and Company Ltd., New Delhi, 2005.
3. Hydraulics and Fluid Mechanics including Hydraulic Machines, Dr.P.N.Modi and Dr.S.M.Seth, Standard Book House, New Delhi,2002.
4. A Text Book of Fluid Mechanics and Hydraulic Machines, R.K.Rajput, S.Chand and Company Ltd., New Delhi, 2005.
5. Engineering Fluid Mechanics, K.L.Kumar, Eurasia Publishing House (P) Ltd, New Delhi, 1992.

6. Principles of Fluid Mechanics, M.K.Natarajan, Oxford & IBH Publishing Co. Pvt., Ltd., New Delhi.

**REFERENCE BOOKS:**

1. Advanced Engineering Fluid Mechanics (Second Edition), K.Muralidhar & G.Biswas, Narosa Publishing House, New Delhi, 2005.
2. A Text Book of Fluid Mechanics and Hydraulic Machines, R.K.Bansal, Laxmi Publications, New Delhi, 2005.
3. Theory and Applications of Fluid Mechanics including Hydraulic Machines, K.Subramanya, Tata McGrawHill, 1997.
4. Fluid Mechanics, Hydraulics and Hydraulic Machines Dr.K.R.Arora, Standard Publishers Distributors, New Delhi.
5. Hydraulics, Fluid Mechanics and Fluid Machines, S.Ramamurtham, Dhanpat Rai Publishing Company, New Delhi, 2004.

## **CLEC307 - CONSTRUCTION LABORATORY**

### **Objective**

This course trains the students in standard testing procedures for different components of concrete and provides them an opportunity to design a concrete mix.

Test on cement-test on aggregates-test on fresh concrete-test on Hardened concrete-test on bricks and tiles-test on steel, Timber and other materials. Study of reinforcement detailing for different structural components.

## **CLEC308 - COMPUTER AIDED BUILDING DRAWING**

### **Objective**

Building drawing in accordance with development and control rules satisfying orientation and functional requirements for the following:

### **Drawing manually by Conventional methods**

1. Conventional signs
2. Bonds in brick and stone masonry
3. Plan, elevation and section of simple buildings

### **Computer aided drawing**

1. Buildings with load bearing walls (R.C.C. roof)
2. Buildings with sloping roof (R.C.C. roof and Tiled roof)
3. R.C.C. framed structures
4. Industrial buildings – North light roof structures – Trusses – Gantry arrangements
5. Perspective view for small buildings

### **TEXT BOOKS:**

1. Building Drawing and Detailing - Dr.Balagopal and T.S.Prabhu, Spades Publishers, Calicut, 1987.
2. Mastering in Autocad 2002. George Omura, BPB Publications, New Delhi, 2002.

### **REFERENCE BOOKS:**

1. Building Drawing with an Integrated Approach to Built Environment - M.G.Shah, C.M.Kale and S.Y.Patki, Tata McGrawHill Publishers Limited, New Delhi, 2004.
2. Civil Engineering Drawing and House Planning - B.P.Verma, Khanna Publishers, New Delhi, 1989.
3. Building Drawing - K.Venugopal, Wiley Eastern Limited, Madras, 1984.
4. Civil Engineering Drawing I - Murugesan, Padmini Subbarayan, Pratheeba Publishers, Coimbatore, 1984.
5. Engineering Drawing (BIS Specifications) - K.V.Natarajan, Dhanalakshmi Publishers, 1998.

## **IV SEMESTER**

### **CLEC401 – ENGINEERING MATHEMATICS-III**

#### **AIM**

The course aims at providing necessary basic concepts in probability and random processes. Knowledge of fundamentals and applications of phenomena will greatly help in the understanding of topics such as estimation and detection, pattern recognition, voice and image processing, networking and queueing.

#### **OBJECTIVES**

At the end of the course, the students would,

- Have a fundamental knowledge of the basic probability concepts.
- Have a well-founded knowledge of random processes.
- Acquire skills in the study of tests of significance for large and small samples.
- Understand the concepts of design of experiments and quality control.
- Understand the ideas in reliability engineering.

#### **UNIT-I PROBABILITY AND RANDOM VARIABLES**

Definition – Types of Random variables – Probability distribution function – Probability Density function – Expectation and moments – Moment generating functions – Characteristic function – Joint probability distribution – Joint cumulative distribution function – Marginal probability distribution function – Joint probability density function –

marginal Probability density – Conditional probability density function – Transformations of random variables.

## **UNIT-II RANDOM PROCESSES**

Classification of Random processes – Methods of description of a random process – Special classes of random processes – Average values of Random processes – Stationarity – Analytical representation of a random process – Auto correlation function and its properties – Properties of  $R(t)$  – Cross correlation Function and its properties.

## **UNIT-III TESTS OF SIGNIFICANCE**

Hypothesis testing – Large sampling tests – small sampling tests based on t, F and Chi-square distributions – Interval estimates of mean, standard deviation and proportion.

## **UNIT-IV DESIGN OF EXPERIMENTS AND STATISTICAL QUALITY CONTROL**

Basic principles of experimental design – completely randomized design – Analysis of variance for one way classification or one factor experiments – Randomised block design – Analysis of variance for one way classification or one factor experiments – Randomised block design – Analysis of variance for two factor experiments – Latin square design – Analysis of variance for three factor experiments – RBD and LSD comparison.

Basics of control charts – control charts for variables.

## **UNIT-V RELIABILITY ENGINEERING**

Definition of reliability – Hazard rate and mean time to failure – Exponential and Weibull failure models – system reliability – Series system, Parallel system.

### **TEXT BOOKS:**

1. Probability, Statistics and Random Processes - Veerarajan.T, Tata McGraw – Hill, Second Edition, New Delhi, 2003.
2. Probability Statistics and Queuing Theory - Kandasamy.P, Thilagavathi.K, Gunavathi.K, S.Chand & Co. Ltd., New Delhi, 2004.

### **REFERENCE BOOKS:**

1. A first course in Probability - Ross.S, Pearson Education, New Delhi, 2002.
2. Fundamentals of Mathematical statistics - Gupta.S.C. and Kapur.J.N, Sultan Chand, New Delhi, 1996.
3. Introduction to Probability and Statistics - Schaum's outline series –Lipschutz.S and Schitter.J, McGraw Hill, New Delhi, 1998.

# CLEC402 - SURVEYING-I

## Objective

This is an important supplementary course to a structural engineer, as knowledge of the surveying practices and topography of the site influences the competency of a structural engineer. This course covers the principles and practices of chain and compass surveying, leveling, theodolite surveying, tachometric surveying and triangulation.

## UNIT-I INTRODUCTION

Chain survey: Accessories for chain survey—conventional signs—chaining line, method of booking, base, tie and check lines—setting out angle using chain, cross staff and optical square—traverse by chain and plotting.

## UNIT-II COMPASS SURVEY

Description, setting up and use of prismatic compass—bearing—local attraction and its correction, magnetic and true meridian's—declination—traverse by compass and plotting, co-ordinate system of plotting, adjustments of closing error.

## UNIT-III PLANE TABLE SURVEY

Equipment—Advantage and Disadvantage—radiation, resection and intersection methods—two and three point's problem.

Area and volumes: Computing areas by graphical and analytical method—Simpson and Trapezoidal rules, contouring, areas and volume of earthwork.

## UNIT-IV LEVELLING

Description, setting up and use of Dumpy level—leveling staff—bench marks—recording and reducing level by different methods—types of leveling—permanent adjustment, sensitiveness of bubbly tube, correction for curvature and refraction.

## UNIT-V THEODOLITE SURVEY

Use and adjustment of transit theodolite—measurement of horizontal angle by repetition and reiteration methods—measurement of vertical angles, heights and distances by single and double plane methods—traversing—calculations and plotting by co-ordinate systems—omitted measurements.

## TEXT BOOKS:

1. "Surveying", T.P.Kanetkar, Part I, Pune Vidyarthi Grithe Prakasan, 1786, Sadahirpeth, Pune 411030, 1990.
2. "Surveying-Vol.I & II", Dr.B.C.Punmia, Laxmi Publications, Ninth Edition, 1990.
3. "Text Book of Surveying", C.Venkatramaiah, University Press (India)Ltd., 1996.

## REFERENCE BOOKS:

1. "Plane and Geodetic surveying". Vol I-David Clark CBS Publishers & Distributors, Delhi - 110 032, 1993.
2. "A Treatise on surveying" Middleton and Chadwicks. Vol.I.
3. "Surveying", A.Bannister & S.Raymond, Pitman Publications, Fourth Edition, 1977.

## CLEC 403 MECHANICS OF SOLIDS – II

### Objective

This course deals with important miscellaneous topics in the analysis of structures subjected to complex loadings. This course covers analysis of statically determinate frames by various methods, unsymmetrical bending, combined bending and direct stresses, thin and thick shells and simple vibration problems.

### UNIT – I

Forces in statically determinate frames - Method of Joints - Method of Sections - Graphical method - Deflection of perfect frames - Unit load method - Graphical method - Forces in redundant frames - Castiglianos theorem - Maxwells method -Tension Co-efficient method.

### UNIT – II

Unsymmetrical bending - Stresses in beams subjected to unsymmetrical bending - Deflections of beams under unsymmetrical bending - Shear Centre.

### UNIT – III

Combined bending and direct stresses - Eccentric loading - Middle third rule - Core of a section - Wind pressure on Chimneys - Water pressure on Masonry dams - Theories of failure.

Columns and Struts - Types - Failure modes - Eulers formula - Rankines formula - Gordans formula - Johnsons formula - I.S. code formula - Practical end conditions and Effective length factors - Built-up columns.

### UNIT – IV

Thin Cylindrical and Spherical shells - Assumptions - Internal pressure - Change in volume - Minimum thickness of wall plates.

Thick Cylindrical and Spherical shells - Assumptions - Lames theory - Compound cylinders - Thick spherical shells.

### UNIT – V

Degree of redundancy – Static and Kinematic indeterminacies – Propped cantilever beams – Fixed beams – B.M.D and S.F.D

### Text Books:

1. **Dr.R.K.Bansal**, *Strength of Materials*, Lakshmi Publications, 1998.
2. **R.K.Rajput**, *Strength of Materials*, S.Chand and Co., 1998.

3. **Dr.B.C.Punmia,et al**, *Strength of Materials and Theory of Structures - Vol.I*, Lakshmi Publications, 1992.

**Reference Books:**

1. **Dr.Sadhu Singh**, *Strength of Materials*, Khanna Publishers,1988.
2. **S.Ramamrutham**, *Strength of Materials*, Dhanpat Rai and Sons, 1991.
3. **G.K.Hiraskar**, *Strength of Materials*.
4. **Bedi D.S.**, *Strength of Materials*, S.Chand and Co., 1984.

**CLEC404 - STRUCTURAL ENGINEERING-I**

**Objective**

To introduce the various philosophies of R.C. design and to study in detail the working stress and limit state design of structural elements such as beams, columns, foundations as per IS 456 – 2000 and also to know the design of steel sections for Compression, Tension and Flexural members as per IS 800 – 2007.

**UNIT-I**

Introduction to working stress method - Analysis - Design - Limit state method - R.C. beams - Assumptions - Moment of resistance - Categorisation- Design guidelines - Analysis and Design of Singly-reinforced beams, Doubly-reinforced beams and Flanged beams - Cantilever beams -Lintel beams- Codal provisions.

**UNIT-II**

R.C.Slabs - Categorisation-Effective span-Design guidelines -Cantilever slabs – One - way slabs - Two-way slabs - Simple Stairs- Codal provisions.

**UNIT-III**

Axially loaded columns-Eccentrically loaded columns-short and long columns-isolated footings-combined footings-simple raft foundation-pile foundation-Design based on limit state method.

**UNIT-IV**

Limit State Design - Basic for Design – Ductility - Partial safety factors for loads - Partial Safety Factors for Materials – Deflection Limits.

Bolted connections – Location details of Fasteners - Bearing and Friction Grip type bolts - shear capacity – Tension capacity- Bearing Capacity – Bolts subjected to combined shear and tension – slip resistance – Design of connections as per IS 800-2007 provisions.

Welded connections - Butt joint – Lap joint – Size of weld – Throat thickness – Weld symbols – Weld types - Design of connections as per IS 800-2007 provisions.

**UNIT-V**



Tension members – Types – Bolted and welded connection of Tension members – Design of Tension members as per IS 800-2007 provisions.

Compression members – Effective lengths – Slenderness ratios – Design details – Column Bases Angle Struts – Laced Columns – Battened columns - Design of compression members as per IS 800-2007 provisions.

Beams – Effective span of Beams – Shear - Beams of unsymmetrical sections – Design of beams as per IS 800- 2007 provisions. Plate girders – Elements of a plate girder – Design of web – Design of flanges – Connections –Design of plate girders as per IS 800 - 2007 provisions.

**TEXT BOOKS:**

- 1) **N.Subramanian**, 2008, *Design of Steel Structures*, Oxford University Press
- 2) **Dowling P.J., P.Knowles and G.W.Owens**, 1988, *Structural steel Design*, The Steel Construction Institute and Butterworths, London.

**IS CODES:**

- 1) IS 456 – 2000, Code of practice for plain and Reinforce concrete.
- 2) IS 800 – 2007, General construction in steel –Code of practice
- 3) IS 813 – 1986, Scheme of symbols for welding

**WEB SITE:**

<http://www.steel-insdag.org>

**REFERENCE BOOKS:**

1. **S.Unnikrishna Pillai and Devdas Menon**, *Reinforced Concrete Design*, Tata McGraw Hill Publications, 1988.
2. **Dr.N.Krishnaraju**, *Advanced R.C.Design*, Tata McGraw Hill Publications, 1995.
3. **Dr.B.C.Punmia, et al**, *R.C.Structures* - Vol.1 &II, Lakshmi Publications.2002.
4. **S.K. Duggal**, *Design of Steel Structures*, Tata McGraw Hill Publications, 2000.
5. **P. Dayaratnam**, *Design of Steel Structures*, S. Chand & Co. Ltd., Ramnagar, NewDelhi, 2010.

**CLEC405 - ESTIMATION & VALUATION**

### **Objective**

This course aims to equip the students with current practices in cost and material estimates in addition to valuation practices which makes the students a complete civil or structural engineer.

#### **UNIT – I ESTIMATION**

Estimation - philosophy- purpose - types - conceptual and approximate estimates - detailed estimate - Estimation of quantities for simple buildings, roads and canals

#### **UNIT – II RATE ANALYSIS**

Schedule of rates of materials and labourers -preparation of data for different items of construction work - preparation of abstract

#### **UNIT – III SPECIFICATIONS & TENDERS**

Specifications - Necessity -Types of specifications -Writing technical specifications, tenders - tender documents - tender procedures - drafting model tenders

#### **UNITS – IV CONTRACTS**

Contracts - Types of contracts - Formation of contracts - Essentials of contract conditions  
Construction contract documents - Construction contract conditions - Introduction to arbitration and legal requirements.

#### **UNIT – V VALUATION**

Valuation - Basic principles - Valuation for lands and buildings - Valuation for bank purposes - Valuation for taxation - Valuation for wealth tax - Valuation for gift tax - Capital gains tax- Fixation of rent - Leasehold properties.

#### **TEXT BOOKS:**

1. Fundamentals of Construction Management and Organisation - K.A.Tenah & J.M.Guevara
2. Estimating and Costing in Civil Engineering - B.N.Dutta
3. Practical Valuation - B.Kanaga Sabapathy

#### **REFERENCE BOOKS:**

1. Estimating and Costing - S.C.Rangwala
2. Valuation of Immovable Properties - C.H.Gopinatha Rao
3. Valuation of Real Properties - S.C.Rangwala
4. Estimating, Costing, Specification and Valuation in Civil Engineering, M.Chakraborti, Tenth Edition 1990.

### **Objective**

To give an overview / basis of highway engineering with respect to the development, planning, design, construction and maintenance of highways. This course covers the traffic signals, traffic problems in cities and traffic environment. Also covers the airport layout, terminal buildings and runway details.

#### **UNIT –I**

Classification of roads – Highway alignment and surveys - Highway economics and financing.

Geometric Design of High way – design speed – Cross sectional elements – super elevation –sight distances – Gradients - extra widening at curves.

#### **UNIT –II**

Highway Materials – Aggregates and Bituminous Materials – Selection and testing – Construction methods for Earth roads , Gravel W.B.M roads ,Bituminous pavements and Cement concrete pavements.

#### **UNIT-III**

Traffic Engineering –Traffic volume-Speed and delay studies-Parking and accident studies-Traffic signs, marking and signals –road intersections – Traffic forecasting – Need – limitations – Types of traffic – Forecasts of traffic. Traffic Compositions – Future traffic estimates – Design Vehicle – Dimensions – Types of Design Vehicles.

#### **UNIT-IV**

Nature of traffic problems in cities : Growth of towns – Growth of Traffic – Nature of Present Difficulties – Measures to meet problems – Need for Study – Land use and City Planning Controls – Restrain measures – Public transport – Promotion of public transport pedestrianisation – Staggy traffic hours.

Traffic and free environment – Effects of traffic on the environment – Noise – Air – Vibration- Degrading the aesthetics - Land consumption – Evaluation procedures – Environmental areas – computer application in traffic engineering – Public transport systems – Simulation, Traffic Planning and Computer application – situation in India.

#### **UNIT-V**

Airports-their importance-spacing and position in relation to their zone - details of their location and layout - auxiliary and terminal buildings - their location and layout.

Runway lighting and drainage – Other accessories such as hangers and repair yards-airport zoning.

**TEXT BOOKS:**

1. Highway Engineering, C.E.G.Justo and S.K Khanna, New Chand & Bros., Roorkee, 1994.
2. Highway Engineering and Airports, S.B.Sehgol, K.L.Bhanot, S.Chand Company Limited, 1980.
3. Basic Highway Engineering, S.P.Bindra, Dhanpat Rai & Sons, 1977.
4. Highway Engineering, Rangwala, Charotar Publications, 2002.

**REFERENCE BOOKS:**

1. Highway Engineering, L.Kadiyali, 2-B, Nath Market, Naisarak Delhi -110 006, 1991.
2. Highway Engineering-Paul K Wright and Karen K. Dixon, Replica Press Limited, Kundli, Seventh Edition.
3. Transportation Engineering & Planning, C.S.Papacostas, P.D.Prevedouros, Prentice Hall of India, Third Edition, 2001.

**CLEC407 - S.M.LABORATORY****Objective**

To study the properties of materials when subjected to different types of loading.

Simple machines- Mechanical advantage and efficiencies for screw jack, worm and wheel, differential wheel and axle etc.

Material testing: Tension, compression and shear tests on different materials-bending and deflection test on beam, Hardness, impact and ductility tests on metals-Torsion test on springs-Test on materials used in concrete –properties and control test on concrete workability and durability test

**CLEC408 - SURVEY LABORATORY****Objective**

The objective of this course is to train the students to acquire skill in operation of various survey instruments and to obtain accurate results.

**1. CHAIN SURVEY :**

1. Study of chain and accessories used in chain survey.
2. Measurement of lengths.
3. Use of cross staff.
4. Methods of overcoming obstacles in chaining.
5. Traverse-Chain angle method and plotting.

**2. COMPASS SURVEY:**

1. Prismatic compass-study and observation of bearings.
2. Determination of inaccessible distances.
3. Traverse by chain and compass plotting.

**3. PLANE TABLE SURVEY:**

1. Study of plane table, plane table survey, Radiation method.
2. Plane table survey by intersection method.
3. Traverse-by plane table
4. Three point problems
  - (a) Bessel's method.
  - (b) Trial and error method.

#### **4.LEVELLING:**

1. Study and operation of Dumpy level and staff.
2. Fly level and spot levels.
  - (a) Height of collimation method.
  - (b) Rise and fall method.

## **V- SEMESTER**

### **CLEC501 - NUMERICAL METHODS**

#### **Objective**

Closed form solutions are not always possible and necessary in the solution of many differential and partial differential equations describing various structural phenomena. Hence numerical methods offer easier and less cumbersome procedures for the solution of such equations. This course covers the finite difference techniques and power series methods of solution of these equations.

#### **UNIT-I**

Method of Finite Difference: Finite Difference Operators-E,  $\Delta$  Solution of First and Second Order Linear Difference Equations with Constant Coefficients - Non-homogeneous Linear Difference Equations with Constant Coefficients.

#### **UNIT-II**

Interpolation-Newton-Gregory Forward and Backward, Interpolation - Newtons Divided Difference Formula-Lagranges Interpolation Formula for Unequal Intervals-Gauss Interpolation Formula-Sterling Interpolation Formula-Numerical Differentiation-Numerical Integration-Trapezoidal Rule-Simpsons 1/3 and 3/8 Rule.

#### **UNIT-III**

Numerical solution of Algebraic and Transcendental Equations - Balzano's Bisection Method - Successive Approximation Method-Regular-Falsi Method-Newton-Raphson Method, Graffies' Root Squaring Method.

Numerical solution of simultaneous Linear Algebraic Equations - Gauss Elimination method - Gauss Jordan Elimination Method- Gauss Siedel Iteration Method - Crout's method.

#### **UNIT-IV**

Numerical Solutions of Ordinary Differential Equation of First, Second Order and Simultaneous Equations-Taylor's Series Method – Euler's Method-Improved Eulers Method-Modified Euler's Method.

Runge- Kutta Method of Fourth Order Milne's-Predictor Corrector Method – Picard's Method.

## **UNIT- V**

Numerical Solution of Partial Differential Equations - Elliptic Equation - Poisson's Equation - Laplace Equation - Liebermans' Iterative Method- Relaxation Method - Hyperbolic Equations - One Dimensional Heat Equation - Bender-Schmidt Recurrence-Relation-Crank Nicholson's Implicit Method.

### **TEXT BOOKS:**

1. Numerical Methods in Science and Engineering -Dr. M. K. Venkatraman, National Publishing Co., Madras, September 2005.
2. Numerical Methods - Kandasamy.P, Thilagavathy.K and Gunavathy.K, S.Chand & Co., 2005.
3. Numerical Methods for Science and Engineering Computation - M.K.Jain, S.R.K Iyeagal & R.K.Jain, Wiley Eastern Company, 1984.
4. Numerical Methods in Science and Engineering - S.Rajasekaran, Wiley Publishing Allahabad, 1992.

### **REFERENCE BOOKS:**

1. Applied Numerical Analysis - Gereald.C. F and Wheatley .P.O., Addition Wesley Publishing Company, 1994.
2. Numerical Methods for Mathematics, Science & Engineering - John.H.Mathews, Prentice Hall of India Private Limited., 1994.
3. Numerical solution of Partial Differential Equations: Finite Difference Method, G.D.Smith., and Clarandom., Oxford Press, 1985.

## **CLEC502 - SURVEYING – II**

### **Objective**

The objective of this course is to equip the students with advanced methods of surveying and to introduce elements of curves, triangulation and astronomical surveying.

### **UNIT -I**

Tacheometric surveying: Principles of stadia formula –subtense bar –precise instruments- microptic alidades –microptic and micrometer theodolites-nautical and box sextants-range finders.

### **UNIT - II**

Curves: Elements of simple curve – setting out simple curves by chain and tape method -

Instrumental methods – compound and transition curves – setting out curves by single and double theodolite methods.

### **UNIT - III**

Triangulation: Classification of systems – classification of networks – types of triangulation

Stations – selection of stations – signals – observations from triangulation stations – selection of site for base line – base line measurement – corrections – reduction of measurement.

#### **UNIT - IV**

Adjustment of angles: errors of observations – weighted measurements – method of least squares.

#### **UNIT - V**

Spherical Trigonometry: Definitions of sphere, great and small circles, poles, axis and Secondaries. Arc lengths of great circle and small circle. Spherical triangle, elements of spherical triangle and its solution by trigonometric formula and Napier's rule. Extrameridian observation of sun for determination of latitude, longitude, time and azimuth of survey lines.

#### **TEXT BOOKS:**

1. Surveying & Levelling – Vol.II – T.P.Kanetkar Pune Vidyarthi Griha Prakashan, Pune 411 030, 1990.
2. Surveying – Vol. II & Vol. III – B.C.Punmia Laxmi Publications, Madras, 1992.
3. A Text Book of Advanced Surveying – Arora Standard Book House, 1705-A Naisarak, Delhi- 110 006, 1992.

#### **REFERENCE BOOKS:**

1. "Plane and Geodetic surveying". Vol I-David Clark CBS Publishers & Distributors, Delhi - 110 032, 1993.
2. "A Treatise on surveying" Middleton and Chadwicks. Vol.I.
3. "Surveying", A.Bannister & S.Raymond, Pitman Publications, Fourth Edition, 1977.

### **CLEC 503 STRUCTURAL MECHANICS – I**

#### **Objective**

This course covers the analysis of complex structural elements like fixed and continued beams with different end conditions and arches with varying degrees of redundancy through classical methods of analysis.

#### **UNIT – I**

Column analogy method - Continuous beams – Theorem of three moments- B.M.D & S.F.D

#### **UNIT – II**

Analysis for moving loads - Influence lines (IL) - IL for beams with point load, UDL longer than span, UDL shorter than span and several point loads - Equivalent UDL - Absolute maximum bending moment - IL for trusses.

#### **UNIT – III**

Three-hinged arches - Horizontal thrust - Effect of temperature change - Straining actions - Influence lines - Parabolic and Circular arches - Two-hinged arches - Horizontal thrust - Effect of temperature change - Straining actions - Influence lines - Parabolic and Circular arches.

#### **UNIT – IV**

Cables and Suspension bridges - Equation of the cable - Horizontal thrust on the cable - Tension in the cable - Length of the cable - Effect of temperature on the cable - Stiffening girders in suspension bridges - with three-hinged and two-hinged stiffening girders – IL for moving loads over suspension bridges.

#### **UNIT – V**

Moment Distribution method - Continuous beams - Simple frames- Portal frames with and without side sway

#### **Text Books:**

1. **Dr.B. C. Punmia, et al**, *Strength of Materials and Theory of Structures - Vol.I*, Lakshmi Publications, 1992
2. **S.Ramamrutham & R. Narayan**, *Theory of Structures*, Dhanpat Rai and Sons, 1992.

#### **Reference Books:**

1. **C. S. Reddy**, *Basic Structural Analysis*, Tata McGraw Hill Book Co., 1996.
2. **C. K. Wang**, *Intermediate Structural Analysis*, Tata McGraw Hill Book Co., 1984.
3. **Vazirani and Ratwani**, *Analysis of Structures - Vol.I*.

## **CLEC 504 SOIL MECHANICS**

### **Objective**

This is one of the core courses necessary for successful structural engineering practice. An understanding of the nature, properties and behavioural response of soils is essential for a safe and stable design of foundations. This course covers the principles involved in the understanding of the behaviour of soils as a supporting medium for structures.

#### **UNIT – I**

Introduction - Soil problems in Civil Engineering - the nature of soil-Soil description and classification for Engineering purposes.

Compaction - Soil compaction - Theory & comparison of laboratory and field compaction methods.



## **UNIT – II**

Soil water and water Flow - Soil water - Static pressure in water - permeability measurement in the laboratory and field - flow through porous strata - Flow net and its properties - Flow net around a sheet pile only.

## **UNIT – III**

Stress distribution and settlement - Effective stress concept in dry and saturated soils - Stress distribution in soil media - use of influence charts - Components of settlements - Immediate and consolidation settlements – Terzaghi's one dimensional consolidation theory.

## **UNIT - IV**

Shear strength of granular materials - shear strength of saturated soil - measurement of shear strength in direct shear and triaxial compression - Mohr Coulomb strength envelope.

## **UNIT - V**

Slope failure mechanisms - total stress analysis for saturated clays - friction circle method, tension cracks - use of stability number.

### **Text Books:**

1. **Dr. B. C. Punmia**, *Soil Mechanics & Foundation Engineering*, Lakshmi Publications, 2005.
2. **V. N. S.Moothy** , *Soil Mechanics & Foundation Engineering*.
3. **Arora**, *Soil Mechanics & Foundation Engineering*.
4. **C. Venkataramaiah**, *Geotechnical Engineering*.

### **Reference Books:**

1. **Cooper**, *Problems in Engineering Soils*.
2. **Shamsher Prakash**, *Problems in Soil Mechanics*.
3. **K.Terzaghi and R.B.Peck**, *Soil Mechanics in Engineering Practice*.

## **CLEC505 - STRUCTURAL ENGINEERING-II**

### **Objective**

This course covers the design of R.C.C multistoreyed complicated structures, retaining walls, water tanks and Bridges based on limit state design. This course also enables the students to develop confidence in the design of steel roof trusses and its elements.

#### **UNIT I**

Analysis and design of multi-storeyed frames for gravity loads and wind loads – substitute frames method- portal and cantilever method- Design based on Limit state method.

#### **UNIT-II**

Retaining Walls- Cantilever type and Counterfort type retaining Walls- Design based on Limit state method.

#### **UNIT-III**

Water tanks- Tanks resting on ground- elevated water tanks-staging for water tanks- Design based on Limit state method.

#### **UNIT-IV**

Design of deck slab for bridges-Design of solid slab bridge- Pigeaude’s curve.

#### **UNIT-V**

Industrial buildings - Types - Elements of an industrial building - Loads on industrial buildings - Wind loads on Industrial Buildings - Roof trusses - Components of a roof truss - Loads on roofs - Design of purlins - Analysis and Design of roof truss.

#### **TEXT BOOKS:**

1. “Reinforced Concrete Structures Vol –II”, B.C. Punmia, A.K.Jain, Arunkumar Jain.
2. “Design of Steel Structures”, N.Subramanian, 2008, Oxford University Press
3. “Limit state Design”- Dr.Ramachandra #I.S.3370(Part-IV)-Code of Practice for Liquid Retaining Structures.
4. “Structural Engineering” – Arulmanickam, Engineering Education Series.
5. “Limit State Design” – Dr.Ramachandra, Standard Book House, Nai Sarak, Delhi, 1990.

#### **IS CODES:**

1. IS 456 – 2000, Code of practice for plain and Reinforce concrete.
2. IS 800 – 2007, General construction in steel – code of practice
3. SP:7-1983, National Building Code of India.
4. SPL 16-1980, Design Aids for R.C.C.

#### **REFERENCE BOOKS:**

1. “Design of Reinforced Concrete Structures”- S.Ramamurtham, Dhanpat Rai & Sons, 2001.
2. “Design of Steel Structures”, P. Dayaratnam, S. Chand & Co. Ltd., Ramnagar, NewDelhi, 2010.

## **CLEC506 - TRANSPORTATION ENGINEERING-II**

### **Objective**

The objective of this course is to introduce railway and waterway transport. Planning and design principles of construction of railway track, tunnel, harbours and docks will also be covered.

#### **UNIT-I**

Railway Engineering - Historical development of Indian railways-railway administration in India-gauges - location and alignment standards-Permanent way - functions and specification of components-typical crossings-maintenance-embankment and cutting - construction, renewal and maintenance of permanent way.

#### **UNIT-II**

Points and crossings-design and layout of the more commonly employed layouts-special fittings and safety devices - stations and yards - different types and their typical layouts-general equipment.

#### **UNIT-III**

Tunnels- introduction - tunnel surveying-soil classification - various tunneling methods in soft strata and hard rock-tunnel shafts and caissons-tunnel lining-tunnel drainage-tunnel ventilation-dust prevention-lighting-modern machines used in tunneling.

#### **UNIT-IV**

Harbours- classification and requirement – choice of site - Principles of design – forms of harbours – signal – breakwater and their uses – types of breakwaters.

#### **UNIT – V**

Channel regulations – dredging – types of dredgers – land reclamation and coastal protection-jetties, docks and basins.

#### **TEXT BOOKS:**

1. Roads, Railways, Bridges and Tunnel Engineering, T.D. AHUJA&G.S.BIRDI, Standard Book House, Delhi, 1985.
2. Railway and Tunnel Engineering, K.SRINIVASAN, Charotar Publishing house, ANAND
3. Harbour Engineering, K.SRINIVASAN, Charotar Publishing house - ANAND.
4. Harbour Dock and Tunnel Engineering, R.Srinivasan & S.C.Rangwala, Charotar publishing house-ANAND, 1985.
5. Elements of Bridge, Railways and Tunnel Engineering, S.P.Bindra & K.Bindra, Dhanpat Rai Publications, 1997.

#### **REFERENCE BOOKS:**

1. Transportation Engineering, V.N.Vazirani & S.P.Chandola, Khanna Publishers, 1983.
2. Dock and Harbour Engineering, N.Hasmuk & E.Sundaramoorthy, Charotar publishing house-ANAND, 1976.
3. Indian Railway Track, M.M.Agarwal, Prabha & Co, New Delhi, 1985.
4. Principles of Railway Engineering, S.C.Rangwala, Charotar publishing house-ANAND, 1967.

### **CLEC507 - SURVEY LABORATORY-II**

### **Objective**

The objective of this course is to train the students to acquire skills in making precise measurements and obtaining accurate results.

Practice Work to cover the syllabus under the subjects **CLEC402** (Unit-V Only) and

### **CLEC502.**

#### **SURVEY CAMP**

A survey camp for 10 days is conducted to train the students to establish horizontal and vertical control as well as setting out for a building.

### **CLEC508-COMPUTER AIDED DESIGN AND DRAWING PRACTICAL-I**

#### **Objective**

This course enables the students in studying and training them in doing the structural drawings themselves for various systems.

#### **Using ACAD**

Plate – 1	- Lintel with Sunshade - Cantilever Canopy
Plate – 2	- Roof/Floor System (Continuous) with flanged beams
Plate – 3	- Footings
Plate – 4	- Strap Footing
Plate – 5	- Raft Foundation
Plate – 6	- Pile Foundation
Plate – 7	- Simple Stairs
Plate – 8	- Multistoreyed Buildings
Plate – 9	- Retaining Walls
Plate – 10	- Elevated Water Tanks
Plate – 11	- Solid Slab Bridge
Plate – 12	- Steel Roof Truss
Plate – 13	- Plate Girder with connection

#### **TEXT BOOKS:**

1. Structural Design and Drawing - Dr. N. Krishnaraju
2. Engineering Graphics using AUTOCAD, T.Jeyapooan, Vikas Publishing House Pvt. Ltd., 2000.
3. Engineering Drawing and Graphics and AUTOCAD, K.Venugopal, New Age International Publishers, 2001.
4. Computer Applications in Civil Engineering, New Chand & Bros., Roorkee, India, 1979.

### **VI – SEMESTER**

#### **CLEC601 - HYDROLOGY**

### **Objective**

This subject aims at making the students to understand the various components of hydrologic cycle, which are responsible for spatial and temporal distribution of water availability in any region.

### **UNIT-I**

Introduction – Definition and scope – Hydrological cycle – The Global water Budget – Practical applications – Meteorology – structure and Constituents of atmosphere – General Circulation – Transitory systems.

### **UNIT-II**

Precipitation – Formation – Types – forms - Measurement – Analysis and Interpretation of Rainfall data – Rainfall mass curve and Rainfall hyetograph, Intensity – Duration – Frequency analysis, Depth – Area – Duration Analysis, Estimation of average depth – Missing precipitation – Double mass curve – Rain gauge network – Climate and weather seasons in India.

### **UNIT-III**

Evaporation – Factors influencing estimation – Measurement – Reducing evaporation - Transpiration - Infiltration – Factors influencing measurement – Equations – Indices.

### **UNIT-IV**

Runoff – Components – Factors influencing Rainfall – Runoff relationships. Hydrograph analysis – Unit hydrograph theory – Applications of UH. Stream flow measurement – Stage - Discharge Relationship – Stream gauge site selection.

### **UNIT-V**

Flood – Design flood – Frequency methods – Flood routing – Reservoir Routing – Channel Routing – Muskingum Routing - Flood forecasting.

### **TEXT BOOKS:**

1. Hydrology and Water Resources Engineering - S.K.Garg, Tata McGraw Hill.
2. Engineering Hydrology-R.Subramanya, New Age International, 2005.
3. Hydrology- H.M. Raghunath, Wiley Eastern Limited, 1986.

### **REFERENCE BOOKS:**

1. Elementary Hydrology-Vijay P.Singh, Prentice Hall of India Pvt. Ltd., 1994.
2. Flood Control and Drainage Engineering - S.N.Ghose, Oxford and IBH Publishing Co. Pvt. Ltd., 1986.
3. Hydrology & Water Resources Engineering-Sharma R.K and Sharma.T.K.

## **CLEC602 - HYDRAULICS AND HYDRAULIC MACHINERY**

### **Objective**

To introduce the various hydraulic Engineering problems like open channel flow, dimensional analysis and also hydraulic machines such as turbines, pumps.

#### **UNIT-I**

Advanced hydraulics: Gradually varied flow in open channels –back water curves – Venturi flume – open channel surges-gauging of rivers and channels.

Dimensional analysis and similitude - Reynold's Froude's Cauchy, Weber and Mach Number-model studies. Rayleigh's and Buckingham  $\pi$  methods.

#### **UNIT-II**

Impact of water on vanes-impulse and momentum-dynamic force on stationary and moving flat and curved vanes-dynamic force on pipe bends-jet propulsion.

#### **UNIT-III**

Turbines: Classification based on action and direction of flow – velocity triangles-calculation of torque, force, discharge, power and efficiency of reaction-impulse and characteristic curves – selection of turbines.

#### **UNIT-IV**

Centrifugal pumps-classification-velocity triangle-calculation of work done and efficiency –minimum starting speed-unit and specific quantities and characteristics curves – effect of change of speed and diameter.

#### **UNIT-V**

Reciprocating pumps: Principle of working – calculation of discharge, slip, work done and efficiency – acceleration head and its effects - friction loss-air vessels.

#### **TEXT BOOKS:**

1. A Text Book on Fluid Mechanics & Hydraulic Machines- R.K.Bansal, Lakshmi Publications, 2005.
2. Fluid Mechanics including Hydraulic Machines-A.K.Jain, Khanna Publications, 2005.
3. Hydraulic Machines including FLUIDICS- Dr.Jagdish lal, Metropolitan Book Co (Pvt), 1997.
4. Theory and Applications of Fluid Mechanics including Hydraulic Machines- K.Subramanya, Tata McGraw Hill, 1997.
5. A Text Book of Hydraulics, Fluid Mechanics & Hydraulic Machines- R.S.Khurmi,S.Chand, 2005.
6. A Text Book of Fluid Mechanics & Hydraulic Machines-R.K.Rajput,S.Chand, 2005.

### **CLEC 603 STRUCTURAL MECHANICS – II**

#### **Objective**

This course provides advanced and modern methods of structural analysis of simple and complicated structures and structural systems. This course can also be a prelude to a basic course in finite element analysis.

#### **UNIT – I**

Slope deflection method - Continuous beams - Simple frames - Portal frames. Consistent-deformation method - Continuous beams - Simple frames - Portal frames.

#### **UNIT – II**

Strain energy method - Beams and Frames- Beams curved in plan.

#### **UNIT – III**

Flexibility method - Beams - Trusses - Simple frames - Portal frames.

#### **UNIT - IV**

Stiffness method - Beams - Trusses - Simple frames

#### **UNIT - V**

Stiffness method - Portal frames - Grids - Lack of fit - Temperature stresses – Support settlements - Elastic supports.

#### **Text Books :**

1. **C. S. Reddy**, *Basic Structural Analysis*, Ed.2, Tata McGraw Hill Publications, 1996.
2. **Sarwar Alam Raz**, *Analytical Methods in Structural Engineering*, Ed.2, New Age International, 2001.
3. **W. Weaver and J. M. Gere**, *Matrix Analysis of Framed Structures*, Ed.2, CBS Publishers and Distributors, 1999.
4. **G. S. Pandit and S. P. Gupta**, *Structural Analysis a Matrix Approach*, Tata McGraw Hill Publications, 1981.

#### **Reference Books:**

1. **Dr. N. C. Sinha and Dr. P. K. Gayen**, *Advanced Theory of Structures*
2. **C. K. Wang**, *Intermediate Structural Analysis*, Tata McGraw Hill Publications, 1983.
3. **Vazirani V.N, Ratwani.M.M**, *Advance Theory of Structures and Matrix Method of Analysis*, Khanna Publishers, 1995.

### **CLEC 604 FOUNDATION ENGINEERING**

#### **Objective**

This is an extension course to the basic course on soil mechanics. This course helps the students to apply the principles of soil behaviour learnt in the earlier course towards a safe and stable design of shallow and deep foundations.

#### **UNIT – I**

Shallow Foundations - Types of foundation - choice of foundation type - general principles of foundation design.

Bearing capacity of soils - Bearing capacity of shallow foundations - Ultimate, Net and allowable bearing pressures - Factors influencing bearing capacity - code provisions.

## **UNIT – II**

Site Exploration, Field Tests and Settlement - Methods of site exploration - Sampling procedures and sampling disturbance - Exploration report.

Field tests for determination of bearing capacity - Causes for settlement - Settlement components - Settlements of footing on sands and clays - Code provisions - Minimisation of settlement.

## **UNIT - III**

Earth pressure and retaining walls - States of plastic equilibrium - Rankine and Coulomb theories - Application to the retaining walls of simple configuration - Stability considerations.

## **UNIT – IV**

Piles - Considerations leading to selection of piles - Estimation of individual and group capacity - Static and dynamic approaches - Pile load tests and interpretation - Code provisions.

## **UNIT – V**

Special Foundations - Foundations for bridges - Caissons-well foundations - Cofferdams - Principles of design and construction - Foundations for machinery - Principles of design - Code provisions - Foundations on expansive soils - Use of under-reamed piles.

### **Text Books:**

1. **Dr. B. C. Punmia**, *Soil Mechanics and Foundation Engineering*, Lakshmi Publications, New Delhi, 2005.
2. **V. N. S.Moorthy**, *Soil Mechanics and Foundation Engineering*, Oscar Publications, 1992.
3. **Arora. K.R.**, *Soil Mechanics and Foundation Engineering*, Oscar Publications, 2000.
4. **C. Venkatramaiah**, *Geotechnical Engineering*, Purna, 2003.

### **Reference Books:**



1. **Oza**, *Soil Mechanics and Foundation Engineering*, Tata McGraw Hill Publications, 1969.
2. **Ramaiah and Chickanagappa**, *Soil Mechanics and Foundation Engineering*
3. **J. E. Bowles**, *Foundation Analysis and Design*
4. **Singh & Bharat**, *Soil Mechanics and Foundation Engineering*, Tata McGraw Hill Publications, 1976.
5. **S.K.Garg**, *Soil Mechanics and Foundation Engineering*, 1999.

## **CLEC605 - ENVIRONMENTAL ENGINEERING-I**

### **Objective**

To make the students conversant with basic principles of Water Supply Engineering. This course covers quantification of water, analysis, sources, conveyance, treatment and distribution of water.

### **UNIT-I WATER SUPPLY**

Objectives of public water supply schemes – Health acceptability, adequacy, Convenience and Economy.

Standards and Planning factors for public water supplies in India - water analysis - Population forecasts - Variation in demand pattern.

### **UNIT-II SOURCES OF WATER**

Surface and groundwater sources - Characteristics-impounded storage reservoirs - mass curve analysis - Intake structures-wells, Infiltration galleries, deep tube wells-construction, development and sanitary protection of wells-Estimating yield of wells under steady – state conditions.

### **UNIT-III TRANSMISSION OF WATER**

Pipe and channels for transmitting water - Hydraulics of pipe flow-use of charts and monograms for flow computations-materials for pipes and conduits - Laying, jointing and testing or C.I., R.C.C., A.C. and PVC pipes-Appurtenances of pipes, pumps and pumping stations-selection of pumps.

### **UNIT-IV TREATMENT OF WATER**

Unit Processes of water treatment - Principles, functions and design of mixing basins, flocculators, sedimentation tanks and sand filters. Principles of disinfection – water softening: aeration-iron and Manganese removal.

### **UNIT-V DISTRIBUTION AND STORAGE**

Continuous Vs intermittent supplies, types, functions and requirements - Analysis of distribution networks using Hardy cross method of balancing-Equivalent pipes - elementary methods of pipes sizing - Operation and maintenance – Leak detection - Equalising and service reservoirs - Elevated and ground level reservoirs - location and determination of capacity - appurtenances.

**TEXT BOOKS:**

1. "Water Supply Engineering", by S.K.Garg, Khanna Publishers, 2005.
2. "Elements of Environmental Engineering", by K.N.Duggal, S.Chand & Company, 2004.

**REFERENCE BOOKS:**

1. "Water and Wastewater Engineering", by Fair, G.M. Geyer., I.C., and Okum,D.A.
2. "Environmental Engineering - A Design Approach", by Arcadio P.Sincerosr, Gregoria A.Sincero, Prentice Hall, 2002.
3. "Environmental Science and Engineering", by J.Glynn Henry & Gary W.Heinke, Prentice Hall of India, 2004.

**CLEC 606 - CONSTRUCTION TECHNIQUES AND MANAGEMENT****Objective**

To make aware of the various techniques and practices on various stages of construction, elements of management, project planning and cost analysis.

**UNIT-I**

Modern methods of construction on site, off site construction. Prefabrication techniques-Principles - types-economy - joints and connections Production, transport and erection of precast units.

**UNIT-II**

Construction techniques-modern construction-industrial buildings - systems for housing.

Construction machinery and equipment – excavator-bulldozers – graders - belt conveyors - hoisting and conveying cranes and hoists - wire ropes.

**UNIT-III**

Elements of management-objective and functions of construction management-construction planning and organization-Types of organization-site organization and labour organization.

Organization of PWD and related departments-Functions of the officers-Method of executing work - types of contracts-contract agreements.

**UNIT-IV**

Project planning, scheduling and control - Bar and Gantt charts - development of network - PERT networks - time estimates-frequency distribution - probability distribution-concept of slack-critical path.

**UNIT-V**

CPM Network - comparison with PERT – Activity time estimate events times-concept of floats-critical activities and critical path.

Cost analysis - direct and indirect cost-crash and normal duration-optimum cost – updating - resources smoothing-resources leveling.

**TEXT BOOKS:**

1. Construction Management and Accounts, Harpal Singh, Tata Mc Graw - Hill Publishing Company Limited, New Delhi.
2. Construction Management and Accounts, B.L.Gupta & Amit Gupta, Standard Distributors, 1705B, Nai Sarak, New Delhi-6.
3. Construction Planning and Equipment, Dr.B.Satyanarayanan & S.C.Saxena, Standard Publishers Distributors, 1705B, Nai Sarak New Delhi-6.
4. Construction Management, Dharwadkar PP., Oxford & IBH Publishers, 1995.
5. Construction Management, Subramanya.K., Tata Mc Graw Hill, 1989.

**REFERENCE BOOKS:**

1. Construction Management, Joy P.K., McMillan India Ltd,2005.
2. Construction Management Practice, Raina VK., Tata Mc Graw Hill.
3. Construction Planning, Equipment Methods, Peurifoy, Robert L., Tata Mc Graw Hill, 2004.

**CLEC607 - FLUID MECHANICS AND MACHINES LAB****Objective**

This course gives training to the students in the practical determination of flow parameters of various fluid flow systems.

Co-efficient of discharge, Co-efficient of velocity and Co-efficient of contraction for various types of Orifices and Mouthpieces.

Co-efficient of discharge for Notches.

Friction in Pipes - Losses in Pipelines.

Co-efficient of Venturimeter and Orifice meter - Discharge equation - Co-efficient for different types of Vanes in the impact of jet on vanes.

Characteristic Curves for different types of Centrifugal Pumps, Reciprocating Pumps and Turbines.

**CLEC608 - SOIL MECHANICS LABORATORY****Objective**

At the end of this course student attains adequate knowledge in assessing both Physical and Engineering behaviour of soils through laboratory testing procedures.

Syllabus to cover Soil Mechanics (Fifth Semester).

**VII SEMESTER**

## **CLEC 701 - GROUND WATER ENGINEERING**

### **Objective**

To introduce to the student, the principles of groundwater governing equations, characteristics of aquifers, construction of wells, investigation and artificial recharge of groundwater.

### **UNIT-I**

Occurrence-scope and place of ground water in Hydrologic cycle-origin of ground water-rock properties affecting ground water types of aquifers.

### **UNIT-II**

Ground water and well hydraulics-Darcy's law-coefficient of permeability – laboratory measurement of permeability-field measurement of permeability –general flow equations - steady unidirectional flow-steady radial flow to a well both in confined and unconfined aquifer-steady flow with uniform recharge – unsteady radial flow to a well in confined aquifer –Non equilibrium equation for pumping tests by Theis method and Cooper Jacob method.

### **UNIT-III**

Construction of wells - methods for constructing hollow wells and drilling deep wells-well completion – perforation screens and gravel packing - rings for vertical and radial drilling – collector wells-infiltration galleries.

### **UNIT-IV**

Surface and sub - surface investigations of ground water - Geophysical exploration-electrical methods-seismic refraction methods-subsurface investigation-test drilling and resistivity.

### **UNIT-V**

Artificial recharge of ground water and sea water intrusion - Ghyben-Herzberg relation between fresh and saline water.

### **TEXT BOOKS:**

1. Engineering Hydrology, K.Subramanya., Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.

### **REFERENCE BOOKS:**

1. Ground Water Hydrology, David Keith Todd (University of California, Berkeley) and David Keith Todd (Consulting Engineer INC., John Wiley & Sons, 2004.
2. Ground Water Science, Charles R. Fitts., Academic Press, 2006.

## **CLEC702 - IRRIGATION AND WATER POWER ENGINEERING**

### **Objective**

The course aims at equipping the students with a basic understanding of the principles and operation of irrigation works and hydro electric systems which will help them design hydraulic structural systems and water power installations.

### **UNIT – I**

Necessity for irrigation – Types of irrigation – Duty – Factors affecting duty – Importance – Expressions for duty – canal falls, location types, Comparison, design principles.

### **UNIT – II**

Diversion head works – definition – Weirs – Barrages – Causes of failure – Khosla's theory – Bligh's theory – Factors governing the design of weir or a barrage – Flood banks – Protective works – Retrogression of levels.

### **UNIT – III**

Storage works – Dams – Types – Problems – Methods of construction – Selection of a particular type of a dam – Selection of dam site – Earth dams – Causes of failure – Stability of slopes – Slope protection – Tank bunds – Minor and Major tanks – Design principles – gravity dam, forces acting on dams, modes of failure, high, low dams – functions & types of galleries.

### **UNIT – IV**

Distribution Systems – Design and alignment of main canals – Practical selection of canals – Water logging – alkalinity of soils – Principles of design of drainage canals – Lining of canals – Works for regulation of water levels – Cross drainage and surplus works – Communication works.

### **UNIT – V**

Canal Regulator, Canal Regulation works, Design of Canal Regulator – Water power – History and Development in India – General Principles – Classification – High, Low, Medium head installations – Components of Hydroelectric installations.

### **TEXT BOOKS:**

1. Irrigation and Water Power Engineering – Dr.B.C.Punmia & Lal Pandey, Lakshmi Publications, 2005.
2. Irrigation Engineering and Hydraulic Structures – Santosh Kumar Garg, Khanna Publishers, 2005.
3. Irrigation Engineering and Practices-AM.Michael, Vikas Publishing House.

### **REFERENCE BOOKS:**

1. Irrigation Engineering – M.S.Misra.
2. Principles and Practice of Irrigation Engineering – S.K.Sharma.
3. Principles of Hydrology – Ward R.C. and Robinson, Tata McGraw Hill, 1990.
4. Irrigation Water Resources & Water Power Engineering, Tata McGraw Hill, 1995.

## **CLEC703 - ENVIRONMENTAL ENGINEERING-II**

### **Objective**

To make the students conversant with basic principles of Wastewater Engineering. This course covers details about collection, conveyance, characterization, treatment and disposal of domestic wastewater

### **UNIT-I SEWERAGE**

Definitions-collection & conveyance of sewage-classification of sewerage systems - quantity of sewage – fluctuation of sewage flow - Hydraulics of sewers-self cleansing velocity-shapes of sewers - Design of sewers - Design of storm water drains.

### **UNIT-II CONSTRUCTION OF SEWERS**

Materials for sewers - joints in sewers-laying & testing of sewers – ventilation - cleaning of sewers - sewer appurtenances-sewage – pumping - types of pumps - pumping station.

Principles and layout of House Drainage systems - Sanitary fixtures and fittings - one pipe system and two pipe system-street connection.

### **UNIT-III QUALITY AND DISPOSAL OF SEWAGE**

Characteristics and composition of sewage - Analysis of sewage.

B.O.D and its significance-population equivalent - Objectives of sewage disposal-Methods of disposal - Discharge into bodies of water - self purification of natural waters.

### **UNIT-IV SEWAGE TREATMENT**

Unit Processes in Sewage Treatment-screens, Grit Chamber, Skimming tank-Settling tanks - septic tanks and disposal arrangements- Imhoff tank -Trickling filters - Intermittent sand filters.

### **UNIT-V ADVANCED TREATMENT TECHNIQUES**

Activated sludge process - Primary & Secondary Treatment-Methods of aeration-oxidation pond - Aerated lagoons - Principle& Design of waste stabilization lagoons-objectives of sludge treatment - characteristic of sludge - sludge digestors - Methods of sludge disposal.

### **TEXT BOOKS:**

1. “Environmental Engineering-II”, by B.C Punmia, Lakshmi Publications, 2004.
2. “Water Supply and Sanitary Engineering”, by Rangwala.
3. “Environmental Engineering”, by K.N.Duggal.
4. “Sanitary Engineering”, by S.K.Garg.
5. “Environmental Engineering”, by Kamala & Kanda rao D.L., Tata Mc Graw Hill.
6. “Environmental Engineering”, by Alam Singh & Sharma VS
7. “Environmental Engineering”, by Narayana Rao and Thanikachalam.
8. “Environmental Engineering”, by Pondey D.C., Tata Mc Graw Hill.

## **REFERENCE BOOKS:**

1. "Waste Disposal Engineering", by S.K.Garg.
2. "Waste water Engineering, collection, Treatment and disposal" by Metcalf, L., and Eddy, H.P.
3. "Environmental Engineering", by Davis & Cornwell.
4. "Environmental Engineering", by Peary H.S.
5. "Environmental Engineering", by Gerald, Kiely.

## **CLEC704 - REMOTE SENSING AND GIS**

### **Objective**

To introduce the basic concepts and principles of various components of remote sensing. To provide an exposure to GIS and its practical applications in Civil Engineering.

### **UNIT – I EMR AND ITS INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL**

Definition of Remote Sensing and its components Electromagnetic Spectrum - wavelength regions important for remote sensing - Wave theory, Particle theory, Stefan Boltzman and Wein's Displacement law - Atmospheric scattering, absorption - Atmospheric windows - Spectral signature concepts - Typical spectral reflective characteristics of water, vegetation, soil.

### **UNIT – II PLATFORMS AND SENSORS**

Types of platforms - orbit types, Sun synchronous and Geosynchronous - Passive and Active sensors - Resolution concepts - Payload description of important Earth Resources and Meteorological satellites - Airborne and Space borne TIR and microwave sensors - Types of data products.

### **UNIT – III IMAGE INTERPRETATION AND ANALYSIS**

Types of image interpretation - Visual interpretation keys - Basic elements of image interpretation - Digital image processing - Pre-processing - Image enhancement techniques - Multispectral image classification - Supervised and unsupervised.

### **UNIT – IV GEOGRAPHIC INFORMATION SYSTEM**

Introduction - Maps – Definitions - Map projections - Types of projections - Map analysis - GIS Definition - Basic components of GIS - Standard GIS softwares - Data type- Spatial and 'Non Spatial (attribute data) - Measurement scales - Data Base Management Systems (DBMS).

### **UNIT – V DATA-ENTRY, STORAGE AND ANALYSIS**

Data models: vector and raster - Data compression - Data input by digitization and scanning - Attribute data analysis and integrated data analysis - Modeling in GIS – Highway Alignment Studies - Land Information System.

**TEXT BOOKS:**

1. Remote Sensing and Image Interpretation - Lilles and. M Thomas, and Kiefer.W Ralph, John Wiley and Sons, New York, 2002.
2. Textbook of Remote Sensing and Geographical Information Systems. Second ed. - Anji Reddy, M., B.S. Publications, Hyderabad, 2001.
3. Concepts and Techniques of GIS, C.P. Lo, Albert K.W. Yeung, Prentice Hall of India Pvt. Ltd, 2002.
4. Principles of GIS, Peter A.Burrough, Rachael A. McDonnell, Oxford Univ. Press. 2000.
5. An Introduction to GIS, Ian Heywood, Pearson Education Asia, 2000.

**REFERENCE BOOKS:**

1. Elementary Photogrammetry with applications in GIS, Wolf Paul.R, McGraw Hill, 2004.
2. Remote Sensing and Image Interpretation, Lilles and Thomsan, John Wiley & Sons, 2004.

**CLEC705 - ELECTIVE-I**

Refer Appendix – I

**CLEC706 - ELECTIVE-II**

Refer Appendix – I

**CLEC707 - ENVIRONMENTAL LABORATORY**

**Objective**

Students should be conversant with the experimental procedures for quantitative estimation of important environmental water quality parameters.

1. Determination of **Chloride** content for the given samples.
2. Determination of **Dissolved Oxygen** for the given samples.
3. Determination of **pH** for the given samples.
4. Determination of **Hardness** for the given samples.
5. Determination of **Total Solids (TDS, TSS)** for the given samples
6. Determination of **Turbidity** of various water and wastewater samples using Nephelo Turbidity meter.
7. Determination of **Electrical Conductivity** for the given samples.
8. Determination of **Sulphates** for the given samples.
9. Determination of **Chemical Oxygen Demand** for the given samples.
10. Determination of **Bio-Chemical Oxygen Demand** for the given samples.



11. Determination of **Residual Chlorine** for the given samples.
12. Determination of **Chlorine Demand** for the given samples.
13. Determination of optimum dosage of coagulant using Jar test apparatus.
14. Determination of infiltration capacity in the laboratory using Double ring infiltrometer.

## **CLEC708 – COMPUTER AIDED DESIGN AND DRAWING PRACTICAL-II**

### **Objective**

The objective of this course is to enable the students in studying and understanding structural drawings by training them in doing the structural drawings using AutoCAD for various systems.

#### **Design of the following Irrigation Structures and Drawing the details using AutoCAD:**

- i. Tank Sluice with Tower Head
- ii. A tank surplus weir.
- iii. A canal drop (Notch type )
- iv. A canal regulator cum Bridge
- v. Cross drainage work: Super passage only.

#### **Design of the following Water and Wastewater Treatment Units and Drawing the details using AutoCAD:**

- i. River or canal intake
- ii. Slow sand filter
- iii. Rapid sand filter
- iv. Clariflocculator
- v. Septic tank
- vi. Trickling Filter (Conventional type)
- vii. Activate Sludge Process
- viii. Layout of Water Supply System for a Town
- ix. Layout of Sewerage System for a Town

## **VIII SEMESTER**

## **CLEC801. PRESTRESSED CONCRETE**

### **UNIT-I**

Definition - Principle of prestressing - Techniques of prestressing-systems of prestressing-Material of prestressing - Allowable stresses - Losses in prestressing.

### **UNIT-II**

Design for flexure – slabs-pre-tensional beams-end block-cable layout-Design for shear and bond.

### **UNIT-III**

Ultimate strength of prestressed concrete sections-Analysis and design of composite sections.

### **UNIT-IV**

Continuous beams-Layout of cables - cap cables-concordant cables - linear transformation.

### **UNIT-V**

Miscellaneous structures-Poles-Piles - Columns-Ties-Circular pre stressing – Pipes - water tanks.

### **TEXT BOOKS:**

1. Pre stressed Concrete - N.Krishna Raju
2. Fundamentals of Pre stressed Concrete - Sinha and Roy.
3. IS: 1343-1980 - Code of practice concrete for Pre stressed Concrete.
4. Fundamentals of Pre stressed concrete V.Natarajan.

### **REFERENCES:**

1. Design of Prestressed Concrete Structures - T.Y.Lin.
2. Prestressed Concrete - Vazirani and Chandola.

## **CLEC802-MAINTENANCE AND REHABILITATION OF STRUCTURES**

### **Objective**

To get the knowledge on quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing of structures and demolition procedures.

### **UNIT – I MAINTENANCE AND REPAIR STRATEGIES**

Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance, various aspects of inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.

### **UNIT – II SERVICEABILITY AND DURABILITY OF CONCRETE**

Quality assurance for concrete construction - concrete properties – strength, permeability, thermal properties and cracking – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

#### **UNIT – III MATERIALS AND TECHNIQUES FOR REPAIR**

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Rust eliminators and polymer coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Guniting and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings and cathodic protection

#### **UNIT – IV REPAIRS TO STRUCTURES**

Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire leakage and marine exposure.

#### **UNIT – V DEMOLITION TECHNIQUES**

Engineered demolition techniques for Dilapidated structures – Case studies.

#### **TEXT BOOKS:**

1. Concrete Structures, Materials, Maintenance and Repair, Denison Campbell, Allen and Harold Roper, Longman Scientific and Technical UK, 1991.
2. Repair of Concrete Structures, R.T. Allen and S.C. Edwards, Blakie and Sons, UK, 1987.
3. Repair and Rehabilitation of Steel Bridges, Utpal K. Ghosh, Oxford and IBH Publishing Co. Pvt. Ltd., 1999.

#### **REFERENCE BOOKS:**

1. Concrete Technology – Theory and Practice, M.S.Shetty, S.Chand and Company, New Delhi, 1992.
2. RHDC-NBO - Santhakumar, A.R., Anna University, July, 1992.
3. Training Course notes on Damage Assessment and repair in low Cost Housing, Raikar, R.N., Learning from failures – Deficiencies in Design, Construction and Service – R&D centre (SDCPL), Raikar Bhavan, Bombay, 1987.
4. Estate Management - N. Palaniappan, Anna Institute of Management, Chennai, 1992.
5. Repairs and Rehabilitation of Structures - Lakshmipathy, M. et.al. Lecture notes of Workshop on 29-30<sup>th</sup> October 1999.

## **CLEC803 - INTERIOR DECORATION AND PLANNING**

### **Objective**

This course introduces students to basic design principles, design theory and concept development. Emphasis will be placed on design process, problem solving, spatial organization, anthropometrics and universal design awareness. This course focuses on the fundamental concepts of residential dream room, kitchen and bath design. The students will be introduced to the concept of landscape designing and its importance in interior design.

#### **UNIT – I**

Concept Development: In this design studio the students will be exposed to designing an interior for the first time. The emphasis will be placed on Design process: Analysis, Synthesis and Evaluation. Anthropometrics: data relating to the human body and the standard sizes of furniture and fixtures. Universal design awareness : Definition and principles of Universal design. Presentation techniques : Presentation drawings – use and necessity Difference between presentation and working drawings. Other forms of presentations – models, sketches, photographs etc.

## **UNIT – II**

Theory: Anthropometrics & Ergonomics - Importance of Furniture - Basic Terminology - Maintenance of Furniture

## **UNIT - III**

Design Project – 1 : Dream Room – Design, Concept of space, Sketch presentation, Finishes of space, Exercise. Design Project – 2 : Residential Bathroom – Type of bathrooms, Requirements, Design guidelines for a private bathroom, Change in the profile of a bathroom over the last 10 years, Exercise. Design Project – 3: Kitchen Design – Types of Kitchen, Types of residential kitchens based on shape, Requirements of a residential kitchen, Design guidelines for a residential kitchen, Change in the use of a kitchen over the last 10 years, study of anthropometric data related to kitchens, Exercise.

## **UNIT - IV**

Paneling and partitions : Reasons for using paneling, paneling materials, method of construction, partition types, advantages, applications and method of construction. False Ceiling: Areas of application, types of false ceilings, requirements of a good ceiling material. Staircases : Technical terms, requirements of a good stair, classification of stairs and hand rails and newel posts.

## **UNIT - V**

Fundamentals of Landscaping : Historical background, principles of Landscape design, Elements of design. Process of Landscape Design : Site analysis, Site assessment, developing an understanding of qualities of exterior spaces, Defining use areas. Types of landscaping: Exterior landscaping, Interior landscaping, Transitional zones between interior and exteriors, Xeriscape.

## **TUTORIALS:**

1. Complete interior for a two bedroom residential apartment
2. A residential dwelling for a family of 6 members
3. Single bedroom flat
4. Bungalow type residence

## **REFERENCE BOOKS:**

1. Time Savers Standards for Interior Design and Space Planning  
by Joseph De Chiara
2. Time Savers Standards for Building Types by Joseph De Chiara
3. Landscape Architecture by Simonds
4. Landscape Design : A practical Approach (5<sup>th</sup> Edition) by Leroy G. Hannebaum
5. Magazines and Periodicals

# CLEC804 - ETHICS IN ENGINEERING

## Objective

The Professional engineering practice will be rendered meaningless if service is not offered with a human approach and honest practices. This course deals with what ethics means to an engineer and the ethical practices to be adopted to serve humanity better as service to humanity is service to God.

### UNIT – I

Introduction to Engineering Ethics - Senses of “Engineering Ethics” – Variety of Moral Issues – Three Types of Inquiry – Engineering Ethics and Philosophy.

Need for Engineering Ethics- Moral Dilemmas – Moral Autonomy – Kohlber’s Theory – Gilligan’s Theory – Consensus and Controversy.

Professions and Professionalism - Professions – Membership Criteria – Persuasive Definitions – Multiple Motives.

Model Reasoning and Ethical Theories - Theories about Virtues – Professional Responsibility – Integrity – Self-Respect – Senses of “responsibility”

Theories about Right Action -Utilitarianism – Duty Ethics – Rights Ethics – Testing Ethical Theories.

Self - Interest, Customs, and Religion – Self - Interest and Ethical Egosim – customs and Ethical Relativism – Religion and Divine Command Ethics.

Uses of Ethical theories – Resolving Moral Dilemmas – Justifying Moral Obligations – Relating Professional and Ordinary Morality.

### UNIT – II

Engineering as Social Experimentation – Engineering As Experimentation – Similarities to Standard Experiments – Learning from the past – Contracts with Standard Experiments – Knowledge Gained.

Engineering as Responsible Experimenters – Conscientiousness – Relevant Information – Moral Autonomy – Accountability.

The Challenger Case – Safety issues.

Codes of Ethics – Roles of Codes – Codes and the Experimental Nature of Engineering – Limitations on codes.

A balanced outlook on law – A regulated Society – The trend toward Greater Detail – Industrial Standards – Problems with the Law in Engineering – The Proper Role of Law in Engineering.

Safety and Risk – The concept of Safety – Risks – Acceptability of Risk – Lessons for the Engineer.

Assessment of Safety and Risk – Knowledge of Risk – Uncertainties in Design – Testing for Safety – When Testing is inappropriate.

Risk – Benefit analyses and reducing risk – Personal risk – Public risk and public acceptance – accounting publicly for benefits and risks – incentives to reduce risk – some examples of improved safety – liability.

Three Mile Island - Chernobyl and safe exits – Prior warnings - Chernobyl and a Forerunner - Safe Exit.

### **UNIT - III**

Responsibilities to Employers – Collegiality and Loyalty – Collegiality – Two Senses of Loyalty – Obligations of Loyalty – Misguided Loyalty – Professionalism and Loyalty.

Respect for Authority – Institutional Authority – Morally Justified Authority – Accepting Authority – Paramount Obligations.

Collective Bargaining – Historical Note – Faithful Agent Argument – Public Service Argument – Conclusion.

Confidentiality – Definition – Justification and Limits – Changing Jobs – Management Policies.

Conflicts of Interest – Impairment of Judgment and Service – Gifts and Bribes – Interests in Other Companies – Insider Information – Moral Status.

Occupational Crime – Industrial Espionage – Price Fixing – Endangering Lives.

### **UNIT – IV**

Issues – Professional Rights – Basic Right of Professional Conscience – Institutional Recognition of Rights – Specific Rights: Recognition and Conscientious Refusal – Foundation of Professional Rights.

Whistle-Blowing – Definition – Three Cases – Moral Guidelines – Protecting Whistle-Blowers – Commonsense Procedures – The right to Whistle-Blow – Beyond Whistle-Blowing.

The Bart Case – Background – Responsibility and Experimentation – Controversy – Aftermath – Comments.

Employee Rights – Employee Bill of Rights – Choice of Outside Activities – privacy – Drug Testing – Due process.

Discrimination – Examples – Definitions – Antidiscrimination Laws – Moral Justification of Nondiscrimination Laws – preferential Treatment – Sexual Harassment.

Multinational Corporations – Three Senses of “Relative” Values – “When in Rome” – International Rights – Promoting Morally Just Measures – Technology Transfer and Appropriate Technology – Bhopal.

Environmental Ethics – Case Studies – The Commons and a Livable Environment – Guilty until Proven Innocent? – Internalizing Costs of Environmental Degradation – Technology Assessment – Philosophical View of Nature.

Computer Ethics – Power Relationships – Property – privacy – Professional Issues.

Weapons Development – The Weapons Seesaw – The Engineer’s Involvement in Weapons Work – Defense Industry Problems – Decommissioning Weapons and Lasting Effects.

### **UNIT – V**

Engineers as Managers, Consultants and Leaders - Engineers as Managers – Managers as Professional - Promoting an Ethical Climate – Managing Conflict.

Consulting Engineers – Advertising – Competitive Bidding – Contingency Fees – Safety and Client needs – Provision for resolution of Disputes.

Engineers as Expert witness and Advisers – Experts Witnesses in the courts – Abuses – Advisers in Planning and Policy – making – Normative Models of Advisers.

Moral Leadership – Morally Creative Leaders – Participation in Professional Societies Leadership in Communities – Ideals of Voluntary Service.

Concluding Remarks. Integrity and Ingenuity – Citicorp Skyscraper.

**REFERENCE BOOK:**

1. Ethics in Engineering - Mike W.Martin Roland Schinzinger – Third Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2003.

**CLEC805 – ELECTIVE III**

Refer Appendix – I

**CLEC806 – ELECTIVE IV**

Refer Appendix – I

**CLEC807 - PROJECT**

The Project work should be taken at the beginning of VII semester and the final report need to be submitted by the students on a date fixed by the Head of the Department towards the end of the VIII semester. There will be a viva-voce examination on the project.

**Appendix – I****Objective**

Apart from core subjects, some specialized subjects are introduced in electives with a motive to specialize in a particular field having field applications.

**1. URBAN AND RURAL PLANNING****UNIT-I**

Development of urban planning-ancient and modern planning-industrial contribution to modern planning-stages, types of survey, collection of data-objects and principles of zoning-role of density and floor space index-planning of residential neighborhoods. Industrial areas, Parks and play grounds, schools-Master plan.

Urban renewal-Conservation, re-establishment and redevelopment-slum clearance.

**UNIT-II**

Development of new town-urban, modern and satellite towns.

**UNIT-III**

Levels of planning review and preparation of regional and national planning development control-building byelaws-zoning-town and country planning acts-land acquisition acts.

**UNIT-IV**

Rural Planning-rural urban differences-Principles of rural planning-urbanisation-integral rural development programme.

**UNIT-V**

Rural housing-grouping of houses-Principles and design environmental sanitation-usage of low cost materials.

**2. DRAINAGE AND FLOOD CONTROL ENGINEERING****UNIT-I**

Drainage-importance-land drainage by open channels economics of land drainage-flood ways-under drainage-action of the drains-locations of outlet-tile drain systems - drainability of soils-Highway drainage –airport drainage.

**UNIT-II**

Flood protection by channel improvements-roughness of channel-effect of cut-off pile dykes-tree retardation-revetment.

**UNIT-III**

Flood protection by levees.

**UNIT-IV**

Drainage of levees-maintenance of levees.

**UNIT-V**

Flood Protection by reservoirs-effect of natural reservoirs artificial reservoirs-flood routing-through rivers –through reservoirs.

**REFERENCE BOOK:**

1. Flood Control and Drainage Engineering - S.N.Ghose, Oxford and IBH Publishing Co. Pvt. Ltd., 1986.

**3. INDUSTRIAL WASTE WATER TREATMENT AND DISPOSAL****UNIT-I**

Effects of industrial waste on streams, land and air-Waste water treatment plants-water quality criteria-effluent standards-process modification-methods and material changes, house keeping etc to reduce waste discharge and strength of the waste-established recovery methods for by products within the plant operations.

**UNIT-II**

Characterization of major industrial wastes - chemical manufacturing industries.



### **UNIT-III**

Conventional methods of treatments and disposal of industrial waste water-separation of solids, Sedimentation, Ponding and filtration.

### **UNIT-IV**

Removal of organic contents-biological treatment methods-stabilization ponds-activated sludge process-aerobic and anaerobic digestion-oxidation ditch.

### **UNIT-V**

Physico Chemical Treatment Methods: Neutralization, coagulation, flocculation, absorption-Municipal wastes.

## **4. CIVIL ENGINEERING SYSTEMS ANALYSIS AND DESIGN**

### **UNIT – I**

Introduction to systems engineering - four distinct phases of civil engineering projects: planning, design, construction and operation - design methodology - the notion of a system - functions of the systems engineer - Mathematical decision - making models - statement of mathematical model - classification - methods of finding an optimal solution.

### **Unit – II**

Linear programming - general form of an LP problem - solution techniques - graphical method - simplex method -solution procedures for minimization problem, maximization problem - excess and artificial variables - Degeneracy – Duality.

Special forms of LP problems - transportation problems - obtaining initial feasible solution - assignment problems - integer programming.

### **Unit – III**

Non-linear programming - introduction and scope - optimum - seeking strategies - gradient methods - direct search methods -unconstrained function - constrained functions.

### **Unit – IV**

Dynamic programming - DP terminology - the principle of optimality - allocation process.

### **Unit – V**

Economic aspects of systems engineering - cash flow - interest and equivalence of time - compound interest factors - non-uniform series cash flows -depreciation and salvage value - project appraisal techniques.

### **REFERENCE BOOKS:**

1. Civil engineering systems analysis and design - Alan A. Smith, Ernest Hinton and Roland W. Lewis, John Wiley & Sons, 1983 edition.
2. Civil engineering systems - Andrew B. Templeman, The Macmillan Press Ltd. 1982 edition.
3. Civil and Environmental Systems Engineering - Charles S. Revelle, E.

4. Earl Whitlach and Jeff. R. Wright, Pearson Prentice Hall Inc., New Jersey, 2004 edition.

## **5. ADVANCED HYDROLOGY**

### **UNIT-I**

Hydrologic cycle, space and time scale, classification of hydrologic models, Precipitation: mechanisms, types, spatial and temporal variation, use of I-D-F and D-A-D curves, design storm, probable maximum precipitation. Infiltration: Process description, measurement, modeling - Richard's equation, Green-Ampt model, SCS model.

### **UNIT-II**

Evaporation: process description, modified Penman equation, evaporation control. Evapotranspiration: process description, measurement, Penman - Monteith Equation

### **UNIT-III**

Drainage basin characteristics, stream networks laws. Stream flow: factors affecting base flow, Hydrograph analysis, UH theory, IUH. Watershed modeling: discrete and continuous simulation models.

### **UNIT-IV**

Design flood estimation: PMF estimation, regional flood frequency analysis. Flood routing: reservoir routing, channel routing - Muskingum - Cunge method, Droughts: indicators, classification, forecasting and management.

### **UNIT-V**

Hydrologic Design: uncertainty concepts, first order reliability method (FORM), risk based design of culverts, storm sewers, reservoirs. Basics of stochastic modeling of hydrologic processes.

### **REFERENCE BOOKS :**

1. Applied Hydrology - Ven Te Chow, David R. Maidment and Larry W.Mays, Mc Graw Hill Book Company, 1988.
2. Stochastic Water Resources Technology - N.T.Kottegoda, Macmillan Press, London, 1980.

## **6 - ARCHITECTURE**

### **Objective**

To make the students to know about the basic principles and influences on architecture, history of architecture, planning of various buildings.

### **UNIT-I**

Influences on architecture - nature-climate and topography-man-personality and interests.

## **UNIT-II**

Represented plan-growth of mass from plan - organisation of space-Principles of composition-contrast proportion-scale balance-unity and character of composition.

## **UNIT-III**

Review of history of architecture-Egyptian, classical and Indian architectural elements-walls, columns, roofs and openings.

## **UNIT-IV**

Planning of buildings - simple structures - aspect, grouping, circulation, sanitation and orientation - planning and treatment of interiors - general principles of acoustics - design of auditoriums, lecture rooms-acoustic materials.

## **UNIT-V**

Drawing-line sketches of planned buildings-residences, clinics, community hall-general idea of perspective drawing (course work only).

## **REFERENCE BOOKS:**

1. Architecture: Form, Space and Order - Francis O.K. Ching, VNR, N.Y., 1999.
2. Man, Climate and Architecture - Givoni B., Applied Science, Barking ESSEX, 1982.
3. Planning the Architects Handbook - Edward D. Mills; Butterworth London, 1995.
4. The Urban Pattern City Planning and Design - Gallian B. Arthur and Simon Eisner, Affiliated Press Pvt. Ltd., New Delhi, 1995 .
5. An Introduction to Town Planning Techniques - Margaret Roberts, Hutchinson, London, 1990.

## **7. PREFABRICATED & INDUSTRIAL STRUCTURES**

### **UNIT-I**

Prefabricated structures: Advantages and disadvantages-general principles of prefabrication-suitable fields of application-economy of prefabrication-types of prefabrication.

### **UNIT-II**

Designing of cross section for load carrying structures beams, slabs, columns and floor systems-structural behavior of precast units-handling and erection stresses-joints and connections-dimensions and detailing –production-transport and erection of precast units.

Construction techniques-modular construction-industrial building systems for housing.

### **UNIT-III**

Industrial structures: General-specific requirements for industries like textiles, sugar, cement, chemical, etc,-site layout and external –facilities-standard.

Structural materials used-planning of multi storeyed buildings-shell and R.C frames-workshops and ware houses.

#### **UNIT-IV**

North lights and Monitors-chimneys, bunkers and silos.

#### **UNIT-V**

Functional requirements-layout planning for staircases-lifts-refuse disposals, utilization of waste materials-cranes and conveyor lifting-natural and artificial ventilation-fire protection.

#### **REFERENCES :**

- 1) Planning Industrial Structures - Dunham.
- 2) Industrial Buildings - Ketezum.
- 3) Building for Industry - Water Henn.

## **8. SERVICES IN HIGHRISE BUILDINGS**

### **Objective**

High rise buildings are a pleasure to watch, but they are made a pleasure to live in only when the functional requirements are adequately provided through proper ventilation, sanitation and water supply in addition to safety measures during calamities like fire. This course covers the principles and practices to be followed in the provision of good service systems.

#### **UNIT – I**

Planning of building services – Important considerations – Floor loadings – Building cost – Material requirements.

#### **UNIT – II**

Water supply services – Collection and examination of water samples – Standards – Internal storage and distribution – Bulk water supply – Water treatment – Selection of pumps – Pump rooms and sump.

#### **UNIT – III**

Sanitation services – Sewerage collection and disposal – Storm water drains – Sewage disposal – Septic tanks – Solid waste disposal – Refuse disposal systems.

#### **UNIT – IV**

Lift and Escalators – Types – Selection – Codes and Rules – Structural provisions – Strength considerations – Pits and overheads – Safety precautions.

#### **UNIT – V**

Air-conditioning – Provisions in buildings – Systems.

Acoustics – Noise in buildings – Noise control – Materials – Methods.

Fire fighting services – Classification – Modes of fire – First-aid – Fighting installations – Fire extinguishers – Provisions in building from fire safety angle – Codes and rules.

**TEXT BOOK:**

1. Services in Building complexes and High Rise buildings – V.K.Jain

**REFERENCE BOOK :**

1. Handbook of Utilities and Services in Buildings – Harris.

## **9. WATERSHED CONSERVATION AND MANAGEMENT**

### **Objective**

1. To introduce the student to the concept of dynamic process of a watershed resulting in soil erosion.
2. At the completion of the course the students should be able to understand the appropriate Conservation measures to be adopted for remediation of watershed.

### **UNIT – I WATERSHED**

Watershed - concept - classification - characteristics History of erosion - Erosion problems of India - Approaches to soil and water conservation.

### **UNIT – II SOIL CONSERVATION**

Soil erosion - Types of soil erosion - Controlling soil erosion - Soil erosion by wind and water - soil conservation practices - vegetative practices - mechanical practices - erosion control in torrents and gullies - soil loss estimation models.

### **UNIT – III WATER CONSERVATION**

Need for water conservation - water conservation measures - water harvesting - principle and techniques - flood water harvesting.

### **UNIT – IV WATERSHED MANAGEMENT**

Watershed programmes - factors affecting watershed management - planning of watershed works - watershed water resources - watershed management practices.

### **UNIT – V MANAGEMENT PRACTICES**

Joint forest management - Grass land farming and' management - Range and pastures - Grazing practices Wasteland development.

**TEXT BOOKS:**

1. Soil and Water Conservation Engineering - R. Suresh, Standard Publishers distributors, New Delhi, 2000.

2. Hydrology and Soil conservation Engineering - Ghanshyam Das, Prentice-Hall India, New Delhi, 2000.
3. Watershed Management - Guideline for Indian Conditions - E.M. Tideman, Omega Scientific Publishers, New Delhi, 1996.

## **10. WATER RESOURCES SYSTEMS MANAGEMENT**

### **Objective**

1. To introduce the student to the concept of Mathematical approaches for managing the water resources system.
2. At the completion of the course the students should be able to apply an appropriate system approach to optimally operate a water resource system.

### **UNIT – I SYSTEM APPROACH**

Philosophy of modelling - Goals and Objectives - Basics of system analysis concept - scopes and steps in systems engineering.

### **UNIT – II PHYSICAL AND SOCIO-ECONOMIC DATA**

Collection, evaluation and processing - project appraisal public involvement, master Comprehensive and integrated planning of water resources project.

### **UNIT – III LINEAR PROGRAMMING**

Operations research - introduction - Problem Formulation graphical solution- Simplex method - Sensitivity analysis simple applications.

### **UNIT – IV DYNAMIC PROGRAMMING**

Optimality criteria Stage coach problem - Bellman's optimality criteria - Problem formulation and Solution - simple applications

### **UNIT – V SIMULATION**

Basic principles - Methodology and Philosophy - Model development - input and outputs - Deterministic simulation - simple applications

### **REFERENCE BOOKS**

1. Water resource Systems Planning and Management - Chaturvedi M.C., Tata McGraw Hill inc., New Delhi, 1997 .
2. Principles of water resources Planning - Goodman Aluvin S., Prentice-Hall, India, 1984.
3. Operations Research - Taha, H.A., Macmillan Publication Co., New York, 1995.
4. Design of Water Resources System - Maass, A., Husfchimidt M.M., Dorfman R., Thomas H.A., Marglin S.A and Fair G.M., Harvard University Press, Cambridge, Mass., 1995.
5. Water Resources System Engineering - Hall Warren, A. and John A. Dracup., Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1998.
6. Water Management and Planning - Pillai K.M., 1987.

## **11. SOLID WASTE AND HAZARDOUS WASTE MANAGEMENT**

### **Objective**

The management of solid waste is one of the recent developments in Environmental Engineering. Now a days many hazardous wastes are also emerging and comes as domestic and industrial wastes. This course throws light on the details of solid waste as well as hazardous waste which will be helpful to Civil Engineers in their profession.

### **UNIT - I**

Introduction -goals and objectives of solid waste management - social aspects - health factors - generation of solid wastes - method of disposal as a factor dependent upon the quality of refuse.

### **UNIT – II**

Storage system - dust bins at the streets - collection facility - frequency of collection - method of transport.

Volume reduction - methods - compaction and boiling - grinding of garbage -disposal methods.

Incinerators - design and operation - dust and air pollution problems – use disposal methods cost considerations.

### **UNIT – III**

Sanitary land fill method - site selection machineries involved - cost consideration - environmental factors such as odours, flies and vectors and leachate and groundwater pollution - supervision - of the process operation.

### **UNIT – IV**

Recovery and Reuse - Ocean disposal - impact assessment - precautions required for the operation of the project - cost considerations.

### **UNIT – V**

Composting methods - recommended procedures impact assessment - cost consideration - disposal of industrial solid waste and hazardous refuse - precautions needs.

### **REFERENCE BOOKS:**

1. Solid Waste Management - Haggerty, D.J., Von Nostrand Renihold company, New York, 1973.
2. Municipal Refuse Disposal - NY American Public Works Association, 1966.
3. Refuse Collection Practice - by American Public Works Association, 1967.
4. Management of Solid Wastes in Developing Countries - Flintoff, F., WHO Publication, 1972.

## **12. EARTHQUAKE ENGINEERING**

### **Objective**

Earthquake Engineering has evinced a great deal of curiosity and interest in the wake of the recent Bhuj earthquake and more regions have been added to the list of seismic prone zones. This course deals with the Elements of Engineering Seismology and seismic design philosophy of structures.

## **UNIT -I**

Elements of Engineering Seismology: Earthquake occurrence in the world, causes of earthquake, plate tectonics, earthquake mechanism, seismic zoning map of India & its use. Earthquake Effects:- On, ground and soil liquefaction, buildings, structures, power plants, switch, yards, equipments & other lifeline structures. Secondary Effects- Land and rock slides, liquefaction, fires, tsunami, floods, release of poisonous gases and radiation.

## **UNIT-II**

Earthquake Phenomenon:- focus, epicenter, seismic waves, magnitude, intensity, intensity scale and its correlation with ground acceleration, characteristics of strong ground motions and attenuation, earthquake recording instruments. Do's and Don'ts for protection of life and property

## **UNIT-III**

Introduction to theory of vibrations: Single degree un-damped and damped systems, elastic response to simple load functions & earthquake response spectra.

## **UNIT-IV**

Introduction to seismic Design of Structures: Philosophy and principles of earthquake resistance design- Strength and stiffness, ductility design and detailing (IS: 13920), design of energy absorbing devices, concepts of seismic base isolation and seismic active control. Building forms and architectural design concepts- Horizontal and vertical eccentricities due to mass and stiffness distribution, structural redundancy and setbacks.

## **UNIT- V**

Equivalent static lateral earthquake force on buildings (IS: 1893): Equivalent static method \_ Seismic coefficients-evaluation, estimation of fundamental time period, base shear and its distribution, Vulnerability Atlas.

Performance of building and Structures: Main causes of damage-Intensity of earthquake forces, lack of strength and integrity in buildings, quasi resonance, lack of ductility, lack of detailing. Lessons learnt from the past earthquakes:- case studies of important Indian earthquakes, major world earthquakes, earthquake catalogue, assessment of damage. Use of relevant codes.

## **TEXT BOOKS:**

1. Dynamics of Structures - Anil K Chopra, McGraw-Hill International edition, 1998.
2. Elements of Earthquake Engineering - Jaikrishna and Chandrasekaran, A.R, Sarita Prakashan, Meerut, 1986.

## **REFERENCE BOOKS:**

1. Dynamics of Structures - Clough, R.W. and Penzien, J., Second edition, McGraw-Hill International edition, 1993.
2. Building Configuration and Seismic Design - Arnold, C. and Reitherman, R., John Wiley & Sons, Inc., New York, 1982.
3. Earthquake Resistant Design - Dowrick, D.J., John Wiley & Sons, Chichester, U.K., 1977.
4. Seismic Design of Reinforced and Masonry Buildings - Paulay, T. and Priestley, M.J.N., John Wiley & Sons, Inc., New York, 1992.



5. Guidelines for seismic design of Buildings - National Earthquake Hazard Reduction Programme (NEHRP), , Federal Emergency Management Agency - 312, Washington. DC, 2000.

**LIST OF IS CODES:**

1. IS 1893: 2002 - Criteria for Earthquake Design of Structures, Bureau of Indian Standards, New Delhi.
2. IS 4236: 1976 -- Code of Practice for Earthquake Resistant Design and Construction of Buildings, Bureau of Indian Standards, New Delhi.
3. IS 13920: 1992 - Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice, Bureau of Indian Standards, New Delhi.
4. Explanatory Handbook or Codes for Earthquake Engineering, Special Publication SP 22, Bureau of Indian Standards, New Delhi.
5. Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete (IS 456:2000), Special Publication SP:24, Bureau of Indian Standards, New Delhi.

## **13.HYDRO POWER ENGINEERING**

### **Objective**

This course aims at equipping the students with a basic understanding of the principles of Hydro Power plants and their safety requirements.

#### **UNIT- I**

Pipe flow: Pump - pipeline system, appurtenances, minor losses, water distribution network analysis and design. Transients in pipelines - causes, simple analysis, transient control using surge tanks, air chambers and control valves.

#### **UNIT- II**

Hydraulic Jump, Surge analysis, design of spillways, energy dissipaters, channel transitions. Dam break analysis.

#### **UNIT- III**

Planning, Analysis and design of different types of power plants - Chimneys, Induced draught and Natural draught cooling towers.

#### **UNIT- IV**

Turbo generator Foundation, Material handling structures, Intake towers, storage structures and other supporting structures for equipments.

#### **UNIT- V**

Introduction, Power plant structure, Layout of hydro power plants, Types of power houses, Underground power houses, Types of underground power plants, alignment and layout of cavities, Investigations and studies, Safety requirements, Sizing of a power house, Joints in hydropower plants.

**TEXT BOOKS:**

1. A Text Book of Water Power Engineering - R.K Sharma and T.K.Sharma, S.Chand Publishers, 2003.

**REFERENCE BOOKS:**

1. Hydraulic Engineering - Roberson, J. A. Cassidy and Chaudhry, M. H., Houghton Mifflin, Boston, 1988.
2. Pipeline design for Water Engineers - Stephenson, D., Elsevier Scientific Publishers, 1981.

## **14.ENVIRONMENTAL IMPACT ASSESSMENT**

### **Objective**

Students should be conversant with assessment of environmental impacts due to major infrastructure projects and their management

### **UNIT-I INTRODUCTION**

Impact of Development on Environment and Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) - Objectives - Historical development - EIA Types - EIA in project cycle - capability and limitations Legal provisions on EIA.

### **UNIT-II METHODOLOGIES**

Elements of EIA - Process screening, Methods of EIA Strengths, weaknesses and applicability - appropriate methodology.

### **UNIT-III PREDICTION AND ASSESSMENT**

Socio Economic Impact - Prediction and Assessment of Impact on land, water, air and noise energy impact; Impact on flora and fauna; Mathematical models for prediction; Public participation - Reports - Exchange of Information - Post Audit - rapid EIA.

### **UNIT-IV ENVIRONMENTAL MANAGEMENT PLAN**

Plan for mitigation of adverse impact on environment options for mitigation of impact on water, air and land, flora and fauna; Addressing the issues related to the Project Affected People - Environment management Plan.

### **UNIT-V CASE STUDIES**

EIA case studies on Roads, bridges, ports, Harbour, Airport, Dams, Irrigation projects, Power plants, Railways.

**TEXT BOOKS:**

1. Environmental Impact Assessment Methodologies - Anjaneyulu, Y. B.S. Publications, Hyderabad, 2002.
2. Environmental Impact Assessment - Canter, R.L. McGraw Hill Inc., New Delhi, 1996.
3. Concepts in Environmental Impact Analysis - S.K. Shukla and P.R. Srivastava, Common Wealth Publishers, New Delhi, 1992.

**REFERENCE BOOKS:**

1. Environmental Impact Analysis Handbook - John G. Rau and David C Hooten (Ed)., McGraw Hill Book Company, 1990.
2. Environmental Assessment Source book, Vol. II and III. The World Bank, Washington, D.C., 1991.
3. Handbook of Environmental Impact Assessment Vol. I and II. Blackwell Science, Judith Pelts, New York, 1999.

## **15 - MANAGEMENT SCIENCE**

### **Objective**

To introduce the basic concepts of Management needed for Civil Engineers.

### **UNIT – I BASIC CONCEPTS IN MANAGEMENT**

**Types of business operations** - Sole proprietorship Partnership - Company - Public and- private sector enterprises / Joint ventures, collaborations.

**Functions of Management** - Principles of management - Functions of management - Functions of a manager.

**Production Management** - Planning - Scheduling - Procurement - Inventory control - management tools - L.P. - PERT, CPM, etc.

### **UNIT – II INTRODUCTION TO MARKETING AND FINANCIAL MANAGEMENT**

Market - Marketing, Segmentation, Positioning, Marketing Research, Market Planning, Scope of financial management - Cost accounting Vs Financial accounting, Appraisal of projects, Investment decisions - concept of payback.

### **UNIT – III MATERIALS AND EQUIPMENT MANAGEMENT**

Planning - Identification, Procurement, Schedule and Cost control - systems approach in resource management - ABC analysis, VED analysis, FSN analysis, vendor rating evaluation, buying versus leasing of equipment.

### **UNIT – IV HUMAN RESOURCE MANAGEMENT**

Scope and objectives of HRM - Man power policy and planning - Recruitment and selection - Training performance appraisal - Wage policy and compensation systems - Company union relationship and collective bargaining Accidents - Absenteeism and turn over - Grievances / conflicts - Identification and resolution.

## **UNIT – V INTRODUCTION TO COMPUTER APPLICATION IN CONSTRUCTION MANAGEMENT**

Planning - Scheduling and Resource-analysis - Recording and operations- Project accounting, costing and finance usage of project management software.

### **TEXTBOOKS:**

1. Management, Eighth edition - Konni, Donnel C.O. and Weighnrich. H., McGraw Hill International Book Company, 1997.
2. Marketing Management - Philip Kotler, Prentice-Hall of India, Edition, 1998.

### **REFERENCE BOOKS:**

1. Personal Management - Momoria, Himalaya Publishing Co., 1992.
2. Construction Management and Accounts - Sharma, J.L., Sathya Prakashan, New Delhi, 1994.
3. An Introduction to Project Management - Srinath, L.S. Tata McGraw Hill Publications, 1995.
4. Marketing Management - Rajan Saxena., Tata McGraw Hill publishing Company Limited, 2005.

## **16 - ECONOMICS AND FINANCE FOR CIVIL ENGINEERS**

### **Objective**

Business acumen and a deep insight in economics is imminent to be successful in civil engineering practice. This course teaches the basics of economics, finance and accounting necessary for a Civil Engineering enterprise to be successful and profitable.

### **UNIT-I**

Economics – Role of Civil Engineering in Industrial development - Support matters of economy as related to engineering - Market demand & supply - Choice of technology Quality control and production - Audit in economic law of returns governing production.

### **UNIT-II**

Land and construction economics - Urban land use and values - Construction development in housing, transport and other infrastructures - Economics of ecology, environment, energy resources, local material selection, form and functional designs - Construction workers - Urban problems - Poverty - Migration - Unemployment- Pollution.

### **UNIT -III**

Financing - Need for financial management - Types of financing - Short-term and Long term borrowing - Leasing - Equity financing - Internal generation of funds - External commercial borrowings - Assistance from government - International financial corporations - Analysis of financial statements - Balance sheet - Profit and loss account - Funds flow statement - Ratio analysis - Investment and Financing decision - Financial control - Job control - Centralized management.

## **UNIT-IV**

Accounting method - General - Cash basis of accounting - Accrual basis of accounting - Percentage completion method - Completed contract method - Accounting for tax reporting purposes and financial reporting purposes.

## **UNIT-V**

Cost estimating of Civil Engineering equipment – Depreciation and Interest – Maintenance and Repair costs – Degree of utilization – equivalent annual cost – operating cost standards – exercises. Project Benefit Cost analysis – least cost – Net Present Value (NPV) – equivalent annual cost method – Internal Rate of Return method (IRR) – Benefit – Cost Ratio – exercises.

## **TEXT BOOKS:**

1. Total Project Management-the Indian context - P. K. Joy
2. Fundamentals of Construction Management and Organisation - K. A. Tenah & J., M.Guevara

## **REFERENCE BOOKS:**

1. Urban Economics - Warner Z.Hirsch
2. Engineering Economics - Mitchel, Robert L., John Wiley & Sons, UK, 1980.
3. Cost – Benefit Analysis for Engineers and Planners - Snell, Michael, Thomas Telford Publishers, London, UK, 1997.
4. Civil Engineering Systems Analysis and Design - Alan A.Smith, Ernest Hinton and Roland W. Lewis, John Wiley and Sons, UK, 1983.
5. Civil and Environmental Systems Engineering - Charles S.Revelle, E.Earl Whitlatch and Jeff.R.Wright, Pearson Prentice Hall Inc., New Jersey, USA, 2004.

# **17. ENTREPRENEURSHIP**

## **Objective**

- ❖ Develop an entrepreneurship spirit
- ❖ Help the participants to identify business opportunities within an organization or independently
- ❖ Initiate action on the business plan from the prospective business through EDC

## **UNIT – I INTRODUCTION**

Introduction to the course entrepreneurship definition, nature and importance. Theories of entrepreneurship. Types and barriers to entrepreneurship. Corporate entrepreneurship. Entrepreneurship versus managers. Motivation converting dream to reality. Role of networks. Entrepreneurship – emerging scenario.

## **UNIT – II IDEA GENERATION**

Entrepreneurship and Innovation. Innovation and imaging innovation. The role of incubation in innovation. Innovation diffusion. Idea to an entity – business ideas and opportunity. Idea generation workshop.

## **UNIT – III FUNCTIONAL AREAS**

Communication for business. Products and markets negotiation skills. IT for entrepreneurs. people issues in entrepreneurship. Ethics for entrepreneurs. Financing the new business - venture capitalists, financial institutions. and banks.

## **UNIT - IV DEVELOPMENT ORGANIZATIONS**

World Trade Organization (WTO), World Intellectual Property' Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS). Technology acquisition and Intellectual property rights. Role of agencies involved in 'promoting and assisting SSI units and facilities offered.

## **UNIT - V BUSINESS PLAN**

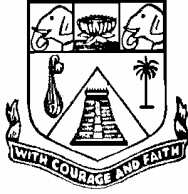
Objectives of business plan, contents - Executive summary, product / service and competition, major sections - measurement of objectives, market analysis, micro environmental influences, financial analysis, management analysis, human resource analysis. Critical risk and contingencies. Summary and conclusions.  
Business plan preparation - Mini project work .

### **TEXT BOOK :**

1. Entrepreneurship by Hisrich (5<sup>th</sup> Edition) - Tata McGraw Hill, New Delhi.

### **REFERENCE BOOKS:**

1. Entrepreneurship by Madhurina Lall & Shikha Salmi - Excel Books New Delhi.
2. Handbook of Entrepreneurship - Sexton and Landstrom.
3. Innovation and entrepreneurship - Peter Drucker – HRB Publication.
4. Small Business Management by William L.Megginson – McGraw Hill (International).
5. Entrepreneurship in the new millennium by Kondaiah – Tata McGraw Hill.
6. New Venture Creation by Jeffry A Timmons - McGraw Hill (International).



**Annamalai University**  
**Annamalainagar**

**DEPARTMENT OF CIVIL ENGINEERING**

**M.E - Environmental Engineering**  
**Degree Programme**

**(Choice Based Credit System)**

**SYLLABI**

## Department of Civil Engineering

### SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. (FULL TIME) DEGREE PROGRAMME IN ENVIRONMENTAL ENGINEERING

#### FIRST SEMESTER

Code	Subject	Period per week				Duration of Exam Hours	Marks			Credit units
		L	P	D	S		Exam	Sess.	Total	
ENV 101	Statistics for Environmental Engineers	4	-	-	-	3	75	25	100	3
ENV 102	Environmental Chemistry and Microbiology	4	-	-	-	3	75	25	100	3
ENV 103	Air Pollution Meteorology and Modeling	4	-	-	-	3	75	25	100	3
ENV 104	Process and unit operations for water treatment	4	-	-	-	3	75	25	100	3
ENV 105	Pipe Line Engineering	4	-	-	-	3	75	25	100	3
ENV 106	Elective - I	4	-	-	-	3	75	25	100	3
ENV 107	Water/Wastewater and Microbiological Laboratory	-	4	-	-	3	60	40	100	2
	Total	24	4	-	-	21	510	190	700	20

L-Lecture P - Practical D-Drawing S - Seminar



**SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. (FULL TIME) DEGREE  
PROGRAMME IN ENVIRONMENTAL ENGINEERING**

**SECOND SEMESTER**

Code	Subject	Period per week				Duration of Exam Hours	Marks			Credit units
		L	P	D	S		Exam	Sess.	Total	
ENV 201	Industrial Wastewater Treatment	4	-	-	-	3	75	25	100	3
ENV 202	Processes and unit operations for wastewater treatment	4	-	-	-	3	75	25	100	3
ENV 203	Environmental Impact Assessment	4	-	-	-	3	75	25	100	3
ENV 204	Solid Waste and Hazardous Waste Management	4	-	-	-	3	75	25	100	3
ENV 205	Air Pollution Monitoring and Control	4	-	-	-	3	75	25	100	3
ENV 206	Elective - II	4	-	-	-	3	75	25	100	3
ENV 207	Advanced Environmental Laboratory	-	4	-	-	3	60	40	100	2
	Total	24	4	-	-	21	510	190	700	20

L-Lecture P - Practical D-Drawing S - Seminar

**SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. DEGREE PROGRAMME  
IN  
ENVIRONMENTAL ENGINEERING**

**THIRD SEMESTER**

Code	Subject	Period per week				Duration of Exam Hours	Marks			Credit units
		L	P	D	S		Exam	Sess.	Total	
ENV 301	Elective III	4	-	-	-	3	75	25	100	3
ENV 302	Elective IV	4	-	-	-	3	75	25	100	3
ENV 303	Thesis Phase - I	-	-	-	3	-	60	40	100	6
	Total	8	-	-	3	6	210	90	300	12

L- Lecture P - Practical D-Drawing S - Seminar

**SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. DEGREE PROGRAMME  
IN  
ENVIRONMENTAL ENGINEERING**

**FOURTH SEMESTER**

Code	Subject	Period per week				Duration of Exam Hours	Marks			Credit units
		L	P	D	S		Exam	Sess.	Total	
ENV 401	Thesis Phase - II	-	-	-	3	-	60	40	100	13
	Total	-	-	-	3	-	60	40	100	13

L-Lecture P - Practical D-Drawing S- Seminar

**ELECTIVES - I TO IV WILL BE CHOSEN FROM THE FOLLOWING LIST**

- ENV E1. Noise Pollution and Control.
  - ENV E2. Transportation of Water and Wastewater.
  - ENV E3 Water Quality Modeling.
  - ENV E4 Project Formulation and Appraisal.
  - ENV E5 Environmental Systems Engineering
  - ENV E6 Indoor Air Quality
  - ENV E7 Environmental engineering Structure
  - ENV E8 Ground water contamination and Transport Modeling
  - ENV E9 Environmental Bio - Technology
  - ENV E10 Remote Sensing and GIS for Environmental Applications
  - \* ENV E11 Mini Project
- (\* Offered as an Elective only in Third Semester in Full -Time Students)

## FIRST SEMESTER

### ENV - 101: STATISTICS FOR ENVIRONMENTAL ENGINEERS

#### Objective

To educate the students in the area of statistics used for solving experimental/ research works.

#### Empirical Statistics

Measures of Central tendency, dispersion, skewness and kurtosis - Principle of least squares - Correlation and regression - rank correlation.

#### Sampling Distributions and Estimation

Sampling distributions - Point and interval estimates for population proportions, mean and variance - Maximum likelihood estimate method - Method of moments.

#### Testing of Hypothesis and Design of Experiments

Sampling distributions - Tests based on Normal, t, Chi-square and F distributions - Analysis of variance - one-way and two-way classifications- Completely randomized design - Randomized block design - Latin square design -  $2^2$  factorial design.

#### Linear Programming

Basic concepts - Graphical and Simplex methods - Transportation problem - Assignment Problem.

#### Probability and Random Variables

Probability - Random Variables - Moments - Standard Distributions - Moment Generating Function - Functions of random variables - Two dimensional random variables - Multiple and partial correlation and Regression.

#### References:

1. Berthouex, P.U., " Statistics for Environmental Engineers ", Lewis Publ., 1994.
2. Freund, J.E. and Miller, I.R., " Probability and Statistics for Engineers ", Prentice - Hall of India, 5th Edition, New Delhi, 1994.
3. Gupta, S.C. and Kapur, V.K., " Fundamentals of Mathematical Statistics ", Sultan Chand & Sons, New Delhi, 1999.
4. Ang, A.H.S. and Tang W.H., " Probability concepts in Engineering Planning and Design - Basic Principles Vol.1 ", John Wiley and Sons, Inc. New Delhi, 1975.
5. Taha, H.A., " Operations Research : An Introduction ", Prentice - Hall of India, 6th Edition, New Delhi, 1997.

## ENV - 102: ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

### PART - A - ENVIRONMENTAL CHEMISTRY

#### Objective

To educate the students in the area of water, air and soil chemistry and train them in the laboratory in the determination of pollutants present in air, water, wastewater and soil.

#### Fundamentals

Colloids - Redox potentials - partition co-efficient - Beer - Lambert's Law - Limitations - UV visible spectroscopy - basic principles - application - Atomic absorption spectroscopy - Principles - applications Gas chromatograph - Principles and applications - Principles of green chemistry - Error Analysis of Environmental Data.

#### Degradation

Transport and transformation of chemicals - DO, BOD and COD - Photo catalysis - Degradation of food stuffs, detergents, pesticides and hydrocarbons.

#### Aquatic Chemistry

Metals, complex formation, oxidation and reduction and sorption -  $E^h$  -  $p^h$  diagrams - chemical speciation - QSAR - Risk evaluation of chemicals.

#### Atmospheric Chemistry

Regions of atmosphere - Chemical and photochemical reactions - photochemical smog, ozone layer depletion - green house gases and global warming - Acid rain.

#### Soil Chemistry

Soil properties, clay minerals - acid-base and ion-exchange reactions in soil - salt affected soil and its remediation.

#### References

1. C.N. Sawyer, P.L. MacCarty and G.F. Parkin, Chemistry for Environmental Engineering and Science, Tata McGraw-Hill, Fifth edition, New Delhi, 2003.
2. G.W. Vanloon and S.J. Duffy 'Environmental chemistry - a global perspective, Oxford University press, New York., 2000.
3. D.W. Connell, Basic concepts of Environmental Chemistry, Lewis publishers, New York, 1997.
4. Colin Baird, "Environmental Chemistry", Freeman and Company, New York, 1997.
5. S.E. Manahan, Environmental Chemistry, Sixth Edition, Lewis Publishers, New York, 1994.

### PART - B - ENVIRONMENTAL MICROBIOLOGY

## **Objective**

To educate the students in microbiology and its applications in environmental engineering, and to train them in experiments related to microbiological examination of water

## **Introduction**

The Characterization, Classification and identification of microorganisms-morphology and fine structure of bacteria. Ecological adaptation and application in pollution abatement. Stain and staining techniques. Pure culture and cultural characteristics. Methods of preservation and Sterilization methods. Nucleic acids-DNA, RNA, replication, Recombinant DNA technology.

## **Microbiology of Environment**

Distribution of microorganisms-Water, Air and Soil, Indicator organisms. Test for coli forms, fecal coli forms, E. coli, Streptococcus-M.P.N. index, M.F. Technique. Algae in water supplies- problems and control.

## **Metabolism of Microorganisms**

Nutrition and metabolism-reproduction and growth, growth phases-kinetics. Carbohydrate, protein, lipid metabolism-aerobic and anaerobic-respiration, fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics.

## **Role of Microorganisms in Wastewater Treatment**

Microbiology of biological treatment processes-aerobic and anaerobic. Biodegradation of toxic pollutants-mechanism-  $\alpha$ -oxidation,  $\beta$ -oxidation, nitrification and denitrification, eutrophication.

## **References**

1. Maier, R.M., I.L. Pepper and C.P. Gerba, "Environmental Microbiology", Academic Press, New York, 1999.
2. Tortora. G.J, B.R. Furke, and C.L. Case, "Microbiology-An Introduction" (4<sup>th</sup> Ed.), Benjamin/Cummings Publ. Co., Inc., California, 1992.
3. Frank C. Lu and Sam Kacew, LU's Basic Toxicology, Taylor & Francis, London (4<sup>th</sup> Ed), 2002
4. Baker. K.H. and D.S.Herson, Bioremediation, McGraw-Hill Inc., New York, 1994.
5. Microscopic World

## ENV - 103: AIR POLLUTION METEOROLOGY AND DISPERSION MODELLING

### Objective

To educate the students in Air Pollution Meteorology and Dispersion Modeling, and to train them in experiments related to Air Quality Models, Air Pollution Meteorological Observatory etc.,

### Introduction to Air Pollution

The Air Pollution Problem - Sources of Air Pollution - Air Pollutants - Effects of Air Pollution - Atmospheric Structure and Dynamics - Composition and Thermal Structure of the Atmosphere - State Variables and Thermodynamics - Atmospheric Stability - Conservation Laws and Atmospheric Dynamics - Large-scale Inviscid Flows - Small-scale Viscous Flows - Applications - Atmospheric systems and pollutant transport - Synoptic Weather Systems - Mesoscale Systems - Microscale Systems - Micrometeorology and Planetary Boundary Layer - Vertical Distributions of Thermodynamic Variables - Vertical Distribution of Winds in the PBL - Turbulence - Gradient-transport Theories - Boundary-layer Parameterization for Dispersion Applications

### Air Pollution Climatology

Effects of Meteorological parameters on Transport and Diffusion - Pollutant Concentration variation - Influence of Topography on Transport and Diffusion - Equation of state and conversion of concentrations - Meteorological roses- Air Pollution Climatology - Interrelationship between Meteorology and Air Pollution - Urban Effects upon Meteorological Parameters- Atmospheric Chemistry of Air Pollution - Natural Removal Processes in the Atmosphere - Analysis of Air Quality Cycles - Meteorological Instruments and their exposure - Applications of Meteorology to Air pollution Potential- Air Pollution surveys - Site Selection for a Potential Source - Atmospheric Tracers and Urban Diffusion Experiments - Meteorological models for Urban Areas - Sources of Meteorological data.

### Statistical Description of Atmospheric Turbulence

Statistical Theory of Turbulence - Observed Spectra and Scales - Effects of Smoothing and Finite Sampling - Lagrangian Description of Turbulence - Parameterization of Turbulence for Diffusion Applications - Gradient Transport Theories - Eulerian Approach to Describing Diffusion - Mass Conservation and Diffusion Equations - Mass Conservation and Diffusion Equations - Molecular Diffusion - Turbulent Diffusion - Constant K (Fickian Diffusion)- Theory - Variable K-Theory -Limitations of Gradient Transport Theories -Experimental



Verification of K-Theories - Applications of K-Theories to Atmospheric Dispersion.

### **Statistical Theories of Diffusion**

Lagrangian Approach to Describing Diffusion - Statistical Theory of Absolute Diffusion - Plume Diffusion from Continuous Sources - Statistical Theory of Relative Diffusion - Puff Diffusion from Instantaneous Releases - Fluctuating Plume Models - Experimental Verification of Statistical Theories - Applications to Atmospheric Dispersion and Limitations - Similarity Theories of Dispersion - Dispersion in Stratified Shear Flows - Lagrangian Similarity Theory for the Neutral Surface Layer - Lagrangian Similarity Theory for the Stratified Surface Layer - The Mixed-layer Similarity Theory - Experimental Verification of Similarity Theories - Applications to Dispersion in the PBL - Limitations of Similarity Theories.

### **Gaussian Diffusion Models**

Basis and Justification for Gaussian Models - Gaussian Plume and Puff Diffusion Models - Diffusion Experiments - Empirical Dispersion Parameterization Schemes - Further Improvements in Dispersion Parameterization - The Maximum Ground-Level Concentration - Model Evaluations and Uncertainties - Limitations of Gaussian Diffusion Models - Practical Applications of Gaussian Diffusion Models - Plume Rise, Settling, and Deposition - Momentum and Buoyancy Effects of Release - Plume-rise Theory and Observations - Gravitational Settling of Particles - Dry Deposition - Deposition Models - Applications - - Short-range Gradient Transport Models - Turbulence Kinetic Energy Models - Higher Order Closure Models - Large-eddy Simulations - Lagrangian Stochastic Models - Urban and Regional Air Quality Models - Components of an Air Quality Model - Urban Diffusion and Air Quality Models - Regional Air Quality Models - Applications of Air Quality Models.

### **References:**

1. Air pollution meteorology and Dispersion, S.Pal Arya, Oxford Press.
2. Air Pollution, Edited by A.C.Stern, Vol. 1 to 3, Academic Press, New York, 1968.
3. Fundamentals of Air Pollution, Williamson, S.J., Addison - Wesley Publishing Co., California, 1973.
4. Meteorology in Atomic Energy, Edited by Slade, D.H., Atomic Energy Commission of the United States of America, Office of information Services, 1968

## ENV - 104: PROCESSES AND UNIT OPERATIONS FOR WATER TREATMENT

### Characteristics of Water

Physical, Chemical, Biological and Radiological Characteristics, Parameters of Analysis: pH, Turbidity, Hardness, Salinity, MPN index, WHO/BIS Standards for Potable Water.

### Preliminary/Primary Treatment Processes

Screening: Bar/Coarse/Fine Screens, Critical velocities, limitations in head loss, Coagulants: Alum & Ferrous salts, Flocculants: Polyelectrolytes, Mixing of Chemicals, Velocity Gradient, Types of Mixing, Processes and types of Settling: Discrete, flocculent, hindered and zone settling, Clarifier, Clari - flocculator, DESIGN APPROACH: Surface loading rates, Hydraulic retention time, Solids loading rates and Weir loading rates.

### Secondary Treatment Processes

Media Filtration: Types of Processes, Specification of filtration media, Slow Sand Filters, Rapid Sand Filters, Pressure Filters, and Multi grade/media Filters, DESIGN APPROACH; Rate of filtration, Head loss calculations, Distribution and collection systems, Carbon Adsorption- Isotherms, Disinfection Processes: Chlorination, Break Point Chlorination-Factors influencing the Chlorine treatment -UV radiation, Ozonation Iron and Manganese Removal methods, Pressure Filters, Isotherms.

### Advanced Treatment Processes

Lime Soda Processes, Ion Exchange, Nano Filtration, Theory of Cross Filtration- Micron Filtration, Ultra Filtration, Nano Filtration and Reverse Osmosis, Membrane based Plants.

### Operation and Maintenance of Treatment Plants

Monitoring and Operating parameters-Instrumentation and Controls-PLC systems-O&M Schedules for Clariflocculators, Filters, Disinfection Chambers and for all membranes based plants, Optimization of treatment Cost.

### References:

1. Metcalf and eddy, Inc., "Wastewater Engineering: Treatment, disposal, reuse ", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1983.
2. Fair, G.M., Geyer, J.C., and Okun, D.A., " Water and Wastewater Engineering ", Vol.1 and 2, John Wiley and Sons Inc., New York, 1981.
3. Howard, S.Peavy, Donald R.Rowe, George Tchobanoglous, "Environmental Engineering ", McGraw-Hill Book Company, Singapore, 1986.
4. Wastewater Treatment Plants, Syed R Qasim, CBS College Publishing, 1985.
5. "Water Quality and Treatment", American Water Works Association, New York, 1967.
6. Wesley Eckenfelder, W., "Industrial water pollution control" Tata McGraw-Hill Publishing Company Ltd., New Delhi.
7. "Manual on Water Supply and Treatment", Third Edition, Ministry of Urban Development, New Delhi, 1999

## ENV 105: PIPELINE ENGINEERING

Introduction - types of water supply systems, piping systems, water distribution networks - labeling network elements - network components - network model - basic hydraulic principles.

Network parameters and types of analysis: Network parameters - Parameter interrelationships - Necessity of analysis - Types of analysis - Rules of solvability of pipe networks - Formulation of equations - single source and multi source networks - Hardy cross method - Newton - Raphson method - Linear theory method - Gradient method and other analysis methods.

Dynamic analysis: Interactive method, Direct method - Analysis considering withdrawal along links - Head dependent analysis and Network Performance Two - demand node serial Network - Performance based analysis - Practical applications.

Node flow analysis: Classification of Nodes - NFA theory - Problem formulation, problem solution and solution procedure - Practical applications.

Water Quality modeling: Model development - Hydraulic models - Chlorine transport - chlorine decay - Mixing in distribution network - Chlorine concentration prediction - Static and dynamic models for chlorine concentration.

Network calibration - Data collection and preparation - calibration methods - practical considerations.

Fuzzy parameters and Network analysis - Parameter interrelationships - Membership function of dependent parameters - sensitivity analysis - unsteady flow analysis - Reliability analysis - Computer application and software packages.

### References:

1. Bhave P.R and Gupta R (2008) Analysis of 'Water Distribution Networks' Narosa Publishing House, New Delhi.
2. AWWA (1996), Water transmission and distribution, second edition, Principles and Practices of water supply operation series, American water works Association.
3. Bhare. P.R (2003) 'Optimal Design of Water Distribution Networks', Narosa Publishing Home, New Delhi.

## ENV 106: ELECTIVE - I

### ENV 107: ENVIRONMENTAL ENGINEERING LABORATORY

#### Water & Wastewater Analysis

pH Meter - Determination of pH of Samples

Conductivity Meter - Determination of Specific conductance of Samples

Turbidity Meter - Determination of turbidity (NTU) of Samples

Jar test apparatus - Determination of the optimum dosage of coagulant

Determination of Chemical Oxygen Demand (COD) of samples

Determination of Biochemical Oxygen Demand (BOD<sub>5</sub>) of samples

Determination of Solids in the samples

(a) Suspended solids

Settleable solids

Non-settleable solids

(b) Dissolved solids

Volatile solids

Fixed solids

Determination of Hardness of samples (EDTA method)

Determination of chloride of samples (Mohr's method)

Determination of Dissolved Oxygen of samples (Winkler's method)

#### Air Pollution & Noise Level Monitoring

Estimation of:

NO<sub>x</sub>, SO<sub>x</sub>, SPM, HC, CO

Noise level

#### Environmental Microbiology

General techniques of microbiology: Media preparation, sterilization, inoculation, cultivation, isolation, purification and enumeration. (plate count, membrane filtration method). Kinetics of bacterial growth: Bacterial growth curve, estimation of number of generations, generation time. Determination of microbial quality of water: standard plate count, standard coliform test, determination of coliform density by MPN method fecal coliform test, fecal streptococcal plate count, Morphological identification of various common soil fungi, Microscopic examination of different algae of water and wastewater

## SECOND SEMESTER

### ENV 201: INDUSTRIAL WASTEWATER TREATMENT

#### Parameters of Analysis

General Characteristics-Organic, Inorganic and refractory organic impurities, Solids, Color, Odor, Temperature, BOD, COD, Total Nitrogen, Total Phosphorous, Heavy Metals. Interpretation of data- Bio degradability- Nutrients- Flow measurements and regulators.

#### Physico - Chemical Treatment

Screening, Flow Equalization, Neutralization, Proportioning, Oil Skimmer, Flotation Reactors, Settling Tank, Clarifiers, Tube Settlers, Pressure Media Filters; Sand, Activated Carbon, Multi media filters

#### Bio - Chemical Treatment

Activated Sludge Process, Extended Aeration, Contact Stabilization, Pure Oxygen Systems, Rotating Biological Contactors, High rate Digesters, FBFF Reactors, UASBR, Combinations of aerobic and anaerobic processes Membrane Bio reactors and Di phasic Digesters.

#### Advanced Treatment

Membrane Technologies; Micro filtration, Ultra filtration, Nano filtration and Reverse Osmosis, Reject Management Systems; Solar Evaporation Pans, Mechanical Evaporators, Common Effluent Treatment Plants/ Zero Liquid Discharge Plants, Operation & Maintenance of ETPs, Measurement of SVI, MLSS, VSS, F/M, Fatty acids, Interpretation of data: Organic Loading Rates, Hydraulic Loading Rates.

#### Methods of Treatment for Industrial Waste Streams

MOEF and CPCB guidelines and Standards for Effluent Treatment and Disposal, Typical Effluent Treatment Schematics for Sugar, Sago, Dairy, Distillery, Textile, Tannery, Electro plating and Pharmaceutical industries.

#### References:

1. " Theories and practice of Industrial Waste Treatment ", Nemerraw, N.L., Addison - Wesley. Pub, Co., 1963.
2. " Principles of Industrial Waste Treatment ", Gurnam, C.F., John Wiley & Sons, Inc., New York, 1965.
3. " The Treatment of Industrial Wastes ", Berselievre, E.B., New York, 1969.
4. Wesley Eckenfelder, W., "Industrial water pollution control" Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. "Manual on Water Supply and Treatment", Third Edition, Ministry of Urban Development, New Delhi, 1999

## ENV 202: PROCESSES AND UNIT OPERATIONS FOR WASTEWATER TREATMENT

### Characteristics

pH, Solids: TSS,TDS,TVS,TFS & TS, BOD, COD, Nutrients, Heavy Metals, Toxic Chemicals, Refractory Organics Bio degradability Standards for Treated Effluent Disposal and Reuse.

### Primary Treatment Processes

Screening, Grit Chamber, Oil Skimmers, Dissolved Air Floatation Reactors, Grit Chambers and Grit removal facilities, Flow Equalization, Neutralization and Proportioning, Mixing: Chemicals for Oxidation and Precipitation, Chemical preparation and Mixing units, Settling: Clarifier, Plate Settlers, Design Approach: Clarifier, Tube Settlers

### Secondary Treatment. Processes

Kinetics of Biological growth- Kinetic coefficients- Monods Equation- Determination of Kinetic constants, Aerobic , Anaerobic Processes and Combinations. Methods of Aeration, Suspended Growth , Attached Growth Systems and Combinations, Activated Sludge Process, Trickling Filters,RBC, **Anaerobic**: digesters, UASBR, Diphasic, **Design Approach** : Aeration Equipments, ASP, Anaerobic Digesters, UASBR.

### Tertiary Treatment Processes

Pressure Media Filters: Activated Carbon Filters, Adsorption Isotherms, Disinfection Processes: Chlorination, UV radiation, Ozonation, **Design Approach** : PSF,ACF and MGF

### Advanced Treatment Processes

TDS Removal : Membrane technologies: Micron Filtration, Ultra Filtration, Nano Filtration and Reverse Osmosis Membrane Flux rates- Reject recirculation- Permeate recovery rates- Operating Pressures-Monitoring parameters- Instrumentation and Control, **Design Approach**: Membrane Based Plants

### Sludge Management Processes

Sludge Volume Index-Sludge Generation rates- Sludge Drying Beds-Solids loading rates, Sludge Dewatering Systems: Centrifuges, Filter Presses, Waste to Energy facilities, Organic Sludge: Composting, Rotary Kiln Incineration, Inorganic Sludge: Secured Land Fill, **Design Approach**: SDBs, Filter Presses, SLF.

### References:

1. Metcalf and eddy, Inc., "Wastewater Engineering: Treatment, disposal, reuse ", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1983.
2. Fair, G.M., Geyer, J.C., and Okun, D.A., " Water and Wastewater Engineering ", Vol.1 and 2, John Wiley adn Sons Inc., New York, 1981.
3. Howard, S.Peavy, Donald R.Rowe, George Tchobanoglous, " Environmental Engineering ", McGraw-Hill Book Company, Singapore, 1986.
4. Wastewater Treatment Plants, Syed R Qasim, CBS College Pubhishing,1985.
5. "Water Quality and Treatment", American Water Works Association, New York, 1967.
6. Wesley Eckenfelder, W., "Industrial water pollution control" Tata McGraw-Hill Publishing Company Ltd., New Delhi.

## ENV - 203: ENVIRONMENTAL IMPACT ASSESSMENT

Introduction - Concept of E.I.A. - Legal aspects - Fiscal incentives for Environmental Protections - Indian Standards and WHO standards for (i) Drinking Water, (ii) Industrial Wastewater Effluent & (iii) Air Quality standards - Necessity for environmental considerations while planning development - factors to be considered - population growth estimate - zoning of urban and industrial areas - restriction and bans on certain developments - town planning concepts - procedural steps.

Baseline data - Air, Water, Soil - Socio - economic survey - Literacy level - Health Facilities, Educational Institutions - Basic Amenities - Landscape consideration - land use plan - Transport, Electricity, Water supply, sanitation - Vegetation and Wild Life - Flora and Fauna - Meteorological and Weather Data - Background Noise level Data.- ISO 14000 - Risk Assessment Methods - Fault Tree Analysis - EIA for Hazardous Wastes.

Environmental Management Plan - Methods of disposal treatment /envisaged - plans to improve the method of treatment - toxic effects - impact on soil quality - groundwater quality and on surroundings in respect of nuisance, vector propagation, air quality etc.- Impact assessment methodologies - weighted impact - response rating criteria - levels of impact on natural resources for the sake of balanced management - long term benefit - mentioning of alternatives - priority ranking of alternatives - pollution control agency - aims and objectives - executive powers - legislative background - relevance to the constitution Cost Benefit Analysis in environmental problems- Public Involvement - Exchange of Information.

Component environment land, water and air - natural quality - pollution sources - degree of pollution - tolerance limits based on scientific data - standards and their criteria - efforts to prevent/control pollution, social objectives - health objectives - economic aspects - protection of environment - planning approaches- Water quality management - concepts - riparian rights - components of water quality management - water uses - monitoring programmes - technology transfer - Common Effluent treatment concept.-Air quality management - emission inventory - ambient - air quality in the region - spotting of violations - corrective measures - technology transfer- Solid waste management-land pollution from solid and liquid wastes - spotting of violations - corrective measures -technology transfer.

Environmental law - provisions in the law for initiating action - categories of penalties - categories of violations - pollution control enforcement strategies - inspections - procedures for serving notice - code of practice applicable to new industries and existing industries - phasing of effecting controls - compliance schedule- Environmental

Audit - role of auditing - history - definitions audit methodology - evaluating audit results - audit reports - case studies.

**References:**

1. " A report on the Assessment of Ambient Air Quality prevailing in the neighbourhood of Tuticorin Thermal Power Station ", Chockalingam M.P., and Pitchai., Submitted to the Government of India, Department of Environment, October, 1984.
2. " Environmental Impact Analysis ", Jain, Urban and Stacey, Van Nostrand Reinhold Co., New York, 1977.
3. " Environmental Assessment ", Bendix and Graham, Ann Arbor Science Publishers, 1978.
4. " Environmental Impact Assessment ", Canter, L.W., McGraw Hill Book Co. 1977.
5. " Water Quality Criteria ", Mekee and Welf., The Resources Agency of California, State Water Quality Control Board, California, 1963.
6. " Environmental Modelling Analysis and Management ", Daets, and Pantell.
7. " Manual on Urban Air Quality Management ", Suess and Graxpord, WHO Geneva, 1979.
8. " Environmental Analysis an Assessment ", Suriyakumaran Co., UNEP/UNAPDI, Bangkok, 1979.
9. " Background material on Environmental Audit", confederation of Indian Industry, New Delhi.

**ENV - 204: SOLID WASTE AND HAZARDOUS WASTE MANAGEMENT**

Introduction - goals and objectives of solid waste management - Operation of Solid Waste Management - Legislative trends and impacts - development of solid waste management - social aspects - health factors - generation of solid wastes - method of disposal as a factor dependent upon the quality of refuse.

Seperation and Storage system - dust bins at the streets - collection facility - frequency of collection - method of transfer and transport - Thermal, Biological and chemical conversion Technologies.

Volume reduction - methods - compaction and baling - grinding of garbage - disposal methods - Incinerators - design and operation - dust and air pollution problems - use disposal methods cost considerations.

Sanitary land fill method - site selection - machineries involved - cost consideration - environmental factors such as odours, flies and vectors and leachate and groundwater pollution - supervision - of the process operation.

Recovery and Re-use - Ocean disposal - impact assessment - precautions required for the operation of the project - cost considerations.

Composting methods - recommended procedures - impact assessment - cost consideration - disposal of industrial solid waste and hazardous refuse - precautions needs.



Sources of hazardous wastes - Characteristics - Handling Methods - Treatment and Disposal Methods.

**References:**

1. " Solid Waste Management ", Haggerty, D.J., Von Nostrand Reinhold company, New York, 1973.
2. " Municipal Refuse Disposal ", NY American Public Works Association, 1966.
3. " Refuse Collection Practice ", by American Public Works Association, 1967.
4. " Management of Solid Wastes in Developing Countries ", Flintoff, F., WHO Publication, 1972.

**ENV - 205: AIR POLLUTION MONITORING AND CONTROL**

Introduction-characteristics of air pollutants-standards-ambient air quality standards-emission standards-sources-effects-measurements-ambient sampling-source sampling-gas flow rates-relative humidity-sample train-determination of size distribution- gas stream calculation-general-emission flow rate and temperature calculations-particulate matter loading-heat content calculation-dilution air calculations-gas stream conditioning-general-mechanical collectors-gas coolers-gas pre heaters.

Fabric Filtration - Introduction- principle and theory- application-general-gas cleaning efficiency-engineering design-pretreatment of an emission stream-air to cloth ratio-fabric cleaning design-bag house configuration-construction material - operations general considerations-collection efficiency-system pressure drop-power requirements-filter bag replacement-management- Cyclones - industrial applications - general description- efficiency - pressure drop- costs of cyclone and auxiliary equipment- a semi empirical approach- Electrostatic Precipitation - principles of operation -corona discharge -electrical field characteristics-particle charging- particle collection- design methodology and considerations- particulate resistivity- internal configuration-electrode system - power requirements-gas flow systems-precipitator housing- flue gas conditioning- removal of collected particles-instrumentation.

Wet And Dry Scrubbing - general process descriptions-wet scrubbing or wet absorption- wet scrubbers- wet absorbents or solvents- wet scrubbing systems- wet scrubber applications- packed tower (wet scrubber) design-dry scrubbers-dry absorbents-dry scrubbing systems- dry scrubbing applications-dry scrubber design - condensation Introduction -process description-types of condensation systems-prevention of VOC emission and condensers- condenser system design variables-engineering design- Flare Process - Introduction-pretreatment and engineering considerations-supplementary fuel requirements-flare gas escape velocity and destruction efficiency

Introduction and definition - adsorption-absorbents-carbon adsorption and desorption - design data -adsorption theory-carbon adsorption theory- carbon adsorption pretreatment-cooling-dehumidification -high VOC reduction-design and operation-design data gathering-type of carbon adsorption systems-design of fixed regenerative bed carbon adsorption systems-design of canister carbon adsorption systems-calculation of pressure drops-summary of application-regeneration and air pollution control of carbon adsorption system-granular activated carbon versus activated carbon fiber.

Gas Phase Biofiltration - Introduction-types of biological air treatment system-general description-novel of emerging designs-operational considerations-general operational considerations-biofilter media -microbiological considerations-chemical considerations-comparison to competing technologies-design consideration/parameters-predesign-packing-case studies-high concentration 2-propanol and acetone-general odor control at a municipal wastewater treatment facility-process control monitoring-limitations of the technology - Emerging Air Pollution Control Technologies - process modification-vehicle air pollution and its control- control technologies and alternate power plants- ultraviolet photolysis-evaluation of ICE's membrane process ,UV process and high efficiency particulate air filters-evaluation of fuel-cell powered vehicles for emission reduction.

#### References:

1. "Air pollution control engineering", Lawrence. Et al., Humana Press, I Ed ( 2004), ISBN - 10 : 1588291615.
2. " Air Pollution Control - A Design approach ", C.David Cooper, et al., Waveland Press, Inc. ISBN 1-57766-218-0
3. " Air Pollution Control Equipment calculations ", Louis Theodore, Wiley, ISBN 978-0-470-20967-7
4. "Air pollution control engineering", Noel de Nevers , Mc Graw Hill, New Delhi.

### ENV 206: ELECTIVE – II

### ENV 207 ADVANCED ENVIRONMENTAL LABORATORY

#### Objective

To conduct laboratory studies on water and wastewater treatment units.

#### LIST OF EXPERIMENTS

- 1) Coagulation and Flocculation.
- 2) Batch studies for sedimentation.
- 3) Characteristics of Filter media.
- 4) Studies on Filtration.
- 5) Water softening.
- 6) Adsorption studies / Kinetics.
- 7) Silt Density Index.

- 8) Reverse Osmosis.
- 9) Kinetics of suspended growth process (activated sludge process).
- 10) Kinetics of attached growth process (Rotating Biological Contactors).
- 11) Sludge volume Index.
- 12) Anaerobic Reactor systems / Kinetics.
- 13) Advanced Oxidation Processes.
- 14) Chlorine Demand Estimation.

**References:**

1. Metcalf & Eddy, Inc. 'Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2003.
2. Lee, CC & Shun dar Lin, Hand book of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
3. Casey T.J. Unit treatment processes in water and wastewater engineering, John Wileys Sons, London, 1993.

**Computer Aided Modelling Laboratory**

Computer programmes with reference to Environmental problems. Each students should develop and execute a minimum of 15 programmes and submit in the form a record

**ELECTIVE COURSES (ENV 106, ENV 206, ENV 301 & ENV 302)**

**ENV E1. NOISE POLLUTION AND CONTROL**

**Sources of Noise**

Industry, Road traffic, Rail traffic, Air traffic, Construction and Public Works, Indoor Sources, Public Gatherings.

**Effects of Noise**

Human hearing mechanism, Interference with Communication, Hearing Loss, Disturbance of sleep, Stress, annoyance, Effects of performance, Miscellaneous effects, Exposure limits.

**Basic Concepts of Sound**

Propagation of Sound Wave Sound Intensity and Sound Power, Sound level and decibel, equivalent and continuous sound pressure level.

**Sound Measurement**

Sound level meters, Types, Components, Community Noise Measurement, Procedure.

**Noise Pollution Control**

Community and Industrial Noise, Control Measures, Control at Source, Control of sound transmission, Reduction in Length of exposure, Education of Public and Workers, Ear Protection, Noise Pollution Control Legislation.

**References:**

1. Environmental Health Criteria - 12, Noise, World Health Organisation Publication, Geneva, 1980.
2. " Environmental Noise Pollution ", Patrick, C.F., John Wiley and Sons, 1977.
3. " Noise and Man ", Burs, W., Lippin Cott., Philadelphia, 1969.

**ENV E2: TRANSPORTATION OF WATER AND WASTEWATER**

Introduction - estimation of the quantity of water needs - storage capacity - impounding reservoirs - intakes - gravity and pressure conduits - hydraulics of fluid flow - pumps and accessories - capacity of pumps - selection of pumps - maintenance - economic design of pumps and pumping mains.

Stresses in pipes - water hammer - causes and prevention materials for pipes - specification - cast iron - wrought iron - steel - concrete - prestressed concrete - asbestos cement plastic and PVC pipes- pipe fittings - pipe joints and specials - service pipes - pipe connections - valves - gates hydrants and meters - control devices - other pipe specials.

Distribution system - principle of design and construction Hardy cross, equivalent pipe and newton-raphson methods method of sections - electrical analogy - maintenance of distribution systems - methods of control and prevention of corrosion - computer applications in network analysis. Storage - distribution and balancing reservoirs - capacity - location - construction - shapes and types - reservoir appurtenances.

Introduction to wastewater engineering aspects - developments and trends in wastewater engineering - investigation part of any project - design of sewerage and drainage systems - sewage flow rates - estimation of sewage flow - infiltration and storm water flows - shape of sewers hydraulics of flow characteristics - methods of measuring flow design of combined sewers - design of separate sewers - velocity limitations - self cleansing velocity - flow conditions in full and partially full sewers - economic depths - sewers networks - transition flow critical depth in sewers - draw down curves and hydraulic jump.

Sewer appurtenances - manholes - catch basins - flushing devices - building connections - sewer junctions - inverted syphons - regulation devices - overflows - out lets - tide gates - ventilation and air relief - maintenance of sewers.

Sewage pump houses - types of pumps - selection criteria - maintenance problems and solutions.

**References:**

1. Wastewater Engineering ", Metcalf and Eddy, Tata Mc Graw Hill Publishing Co., New Delhi,1972.
2. Sewerage and Sewage Treatment ", Babbitt and Baumann, John Wiley & Sons., New York, 1958.
3. Water and wastewater Engineering ", Fair, Geyer and Okun, Vol.I & II John Wiley & Sons, New York, 1966.

**ENV E3: WATER QUALITY MODELING**

Introduction to mathematical modeling - Simulation-Optimization- examples  
- Computer Aided Design - Introduction to Numerical Methods - Systems of Simultaneous Equation - Finite difference approximations to differential equations  
- Partial Differential Equations.

Models of water quality in rivers - convective differential equation - Molecular diffusion and Fick's law - River Models-Analytical and Numerical Solutions - Dissolved Oxygen Sag - Lagrangian Models - Operational Model-Optimization Model- Models of discharge.

Lake and Reservoir Modeling - Factors affecting Water Quality in Lakes - Lake Models -Models of Water quality in Estuaries - Estuarine Hydraulics - Estuarine Models- Finite Difference Models - Surveys and Data requirements.

Ground water Quality Modeling-Governing equations of ground water hydraulics-Analytical solutions-Mass transport

Mathematical model of the discharge of wastewater into a marine environment-Initial dilution in the buoyant jet-Diffusions of neutrally buoyant jet in an ocean current.

**References:**

1. James , A. (ed) An introduction to Water Quality Modeling, John Wiley and sons,NewYork,1984.
2. Biswas,A.K (ed) Systems Approach to Water Management, McGraw Hill,Newyork,1976.
3. Rinaldi,S. et.al, Modeling and Control of River Water Quality, McGraw Hill,Newyork,1979.
4. Bean,J . Dynamics of Fluids in Porous Media Elsevier ,NewYork,1972.

## **ENV E4: PROJECT FORMULATION AND APPRAISAL**

### **Introduction**

Goals of water supply and sanitation programmes, their social relevance, community participation, project planning cycle. Preinvestment planning activities: Methodology, consumer survey and socio-economic studies, preliminary engineering and feasibility studies.

### **Technical Aspects**

Data collection and surveys, planning horizon, demand forecasting, evaluation of alternative sources, design criteria and levels of service, appropriate technology, evaluation of alternative solution.

### **Financial and Economic evaluation**

Financial management in water supply and sewerage undertakings, time value of money, discounted cash flow, financial analysis, financial projections. Economic concepts of supply and demand, economic analysis, economics of water pricing, least-cost analysis, cost benefit analysis, economic feasibility, cost reliability and inflation. Tariff setting Methodology, water metering and its alternatives, water rate philosophies and structures.

### **Institutional and project management**

Concepts, preparation of terms of reference, project costing, consulting services, scheduling, project control, organisation and man-power planning and development, special legislation and regulations, role of Governments and multilateral or bilateral lending agencies.

### **Case studies**

Water Supply and Sanitation.

### **References:**

1. E.D.I. The World Bank, Training materials on Pragmatic Water Planning, Demand forecasting, Ratio analysis, Least cost analysis, Procurement, Cost-benefit analysis, The use of consultants, Sector Planning, Tariff analysis and Compounding and Discounting Techniques, 1982.
2. Baum, W.C., The Project Cycle, pamphlet issued by the World Bank, Washington, D.C., 20433, 1982.

3. Manual on project formulation and appraisal in water supply and sanitation, Prepared by Centre for Environmental Studies, College of Engineering, Guindy, Madras, 1984.

## ENV E5: ENVIRONMENTAL SYSTEMS ENGINEERING

Physical Phenomena: Transport, Gas Transfer, thermal Phenomena, Sedimentation, Continuous Flow Models.

Chemical Phenomena: Solution Equilibriums, Reaction Kinetics, Carbonate Equilibriums, Thermochemistry, Colloidal Behaviour.

Biologic Phenomena: Organic Materials, Microorganisms, Growth Kinetics, Biochemical Oxygen Demand, Anaerobic Decomposition, Photosynthesis, Food Chains.

Ecological Systems: Models, Analytical Solutions, Time Domain Simulation, Continuous Flow Microbiological System, Pesticide Concentration, Eutrophication.

Natural Transport Systems: Basic Models, Dissolved Oxygen System, Streams, Estuaries, Transport in the Air Environment.

Planning Factors: Water Quality Criteria and Standards, Air Pollution and its Control, Radiological Health, Environmental Impact Statements, Population Growth Models, Regional Growth Model, Time Capacity, Expansion of Systems.

Engineered Transport Systems: Pipe Network Analysis, Water Distribution Systems.

Water Treatment Systems: Treatment Trains, Lagoon Systems Individual Household Systems.

### References:

1. Rich, L.G. (1973) "Environmental Systems Engineering", McGraw Hill Inc.
2. Sincero, A.P. and Sincero, G.A. (1999) "Environmental Engineering -A Design Approach:", Prentice Hall of India, NewDelhi.
3. Peavy H.S. Row D.R. and Tchobanaglou G (1995) "Environmental Engineering", McGraw Hill International Edition.
4. Hammer M.J. and Hammer M.J. Jr. (1996), "Water & Wastewater Technology", Prentice Hall of India, NewDelhi.

## Objective

To educate the students on air pollution and control in the indoor environment

### Introduction

Indoor activities of inhabitants -residence time. Levels of many pollutants in indoor and outdoor air. Design and operation of buildings for improvements of public health. IAQ policy issues: sustainability; indoor air quality as a basic human right.

### Indoor Air Pollutants

Air pollutants in indoor environments, private residences, offices, schools, sand public buildings, factors that govern pollutant indoors concentrations, including ventilation. Charateristics, Consequences.

### Control of Pollutants

Control of several pollutant classes, such as radon, toxic organic gases, combustion byproducts, and microorganisms such as molds and infectious bacteria. Case study by an exploration of public policy related to indoor air.

### Concepts and Tools

Concepts and tools: exposure, material-balance models, statistical models  
Ventilation

### Indoor Air Pollution from Outdoor Sources

Indoor air pollution from outdoor sources: particulate matter and ozone; Combustion byproducts; Radon and its decay products. Volatile organic compounds: odors and sick-building syndrome, Humidity Bio-aerosols: infectious disease transmission. Special indoor environments: A/C units in indoor; museums-labs; Measurement methods, Control technologies, Control strategies.

### References:

1. Thaddes Godish, Indoor air and Environmental Quality, CRC press, 2000
2. Nazaroff W.W and L Alvarez-Cohen, Environmental Engineering Science Wiley sons, New York, 2001.
3. Moroni Marco, Seifet Bernd and Lindrall Thomas, Indoor Air Quality: A Comprehensive Reference Book, Elsevier Science, Vol. 3, 1995



## **Design of Pipes**

Structural design of a) Concrete b) Prestressed Concrete c) Steel and d) Castiron piping mains, sewerage tanks design - anchorage for pipes - massive outfalls - structural design and laying - hydrodynamic considerations. Advances in the manufacture of pipes.

## **Analysis and Design of Water Tanks**

Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory and design of various types of folded plates for roofing with concrete. IS Codes for the design of water retaining structures.

Design of circular, rectangular, spherical and Intze type of tanks using concrete. Design of prestressed concrete cylindrical tanks - Economic analysis - introduction to computer aided design and packages.

## **Design of Special Purpose Structures**

Underground reservoirs and swimming pools, Intake towers, Structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks etc. - effect of earth pressure and uplift considerations - selection of materials of construction.

## **Repair and Rehabilitation of Structures**

Diagonising the cause and damage, identification of different types of structural and non-structural cracks - repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

## **References:**

1. Reinforced Concrete by P.Dayaratnam.
2. Prestressed Concrete by Krishna Raju, Tata McGraw-ill Publishing Co. 2nd Edition 1988.
3. Reinforced Concrete by N.C.Sinha & S.K.Roy - S.Chand and Co. 1985.
4. Hulse R., and Mosley, W.H., "Reinforced Concrete Design by Computer", Macmillan Education Ltd., 1986.
5. Ramaswamy, G.S., "Design and Construction of Concrete shell roofs", CBS Publishers, India, 1986.
6. Green, J.K. and Perkins, P.H., "Concrete liquid retaining structures", Applied Science Publishers, 1981.

## **ENV E8: GROUND WATER CONTAMINATION AND TRANSPORT MODELING**

### **Objective**

To educate the students on the hydraulics related ground water contamination and modelling ground water quality.

### **Introduction**

Ground water and the hydrologic cycles - Ground water as a resource - Ground water contamination - Water quality standards - Sources of contamination - Land disposal of solid wastes - Sewage disposal on Land. Ground water and geologic processes. Physical properties and principles - Darcy's Law - Hydraulic Head and Fluid Potential - Piezometers and Nests. Hydraulic conductivity and permeability - Homogeneity and Anisotropy - Porosity and voids Ratio- Unsaturated flow and the water table - Steady state flow and Transient flow - Compressibility and effective stress - Transmissivity and storativity - Equations of Ground water Flow - Limitations of Darcian Approach - Hydro dynamic dispersion.

### **Hydrologic Cycle and Flow Nets**

Flow nets - Graphical construction - Flow nets by numerical simulation. Steady state Regional Ground Water flow - steady state hydrologic budgets - Fluctuations in ground water levels.

### **Resource Evaluation**

Development of Ground Water resources - Exploration for Aquifers - the response of Ideal aquifers to pumping - Measurement of parameters - Laboratory tests - Piezometer test - Pumping tests - Estimation of saturated hydraulic conductivity - Numerical simulation for aquifer yield prediction - Artificial recharge and induced infiltration - Land subsidence - Sea water intrusion.

### **Chemical Properties and Principles**

Constituents - Chemical equilibrium - Association and Dissociation of dissolved species - effects of concentration gradients - Mineral dissolution and solubility - Oxidation and reduction Process - Ion exchange and Adsorption - Environmental isotopes - Field Measurement of Index parameters. Chemical Evolution: Hydro Chemical sequences and facies - graphical methods - Hydro chemical Facies - Ground water in carbonate terrain - Ground Water in crystalline rocks - Ground Water in complex sedimentary systems - Geochemical interpretation of  $^{14}\text{C}$  Dates - Process rates and molecular diffusion.

### **Solute Transport**

Transport process - non-reactive constituents in homogeneous media and Heterogeneous media - Transport in Fracture media - Hydro chemical behavior

of contaminants - Trace metals- Trace nonmetals - Nitrogen, organic substances  
- Measurement of parameters - Velocity - Dispersivity - chemical partitioning.

### **USGS - MOC Model**

Modelling Principles - MOC Modelling. Case studies

### **References:**

1. Randall J. Charbeneau, "Ground water Hydraulics and Pollutant transport  
"Prentice Hall, Upper Saddle River, 1999.
2. Todd David Keith, Ground water Hydrology, Second edition, John Wiley and  
Sons,  
New York, 1980.
3. Allen Freeze, R. and John A. Cherry, "Ground Water", Prentice Hall, Inc., 1979.

## **ENV E9: ENVIRONMENTAL BIOTECHNOLOGY**

### **Objective**

To educate the students on the principles and application of biotechnology in  
environmental engineering with special reference to waste treatment.

### **Introduction**

Principles and concepts of environmental biotechnology—usefulness to  
mankind, current status.

### **Detoxification of Environmental Pollutants**

Degradation of high concentrated toxic pollutants—halogenated, non-  
halogenated, petroleum hydrocarbons, metals. Mechanisms of detoxification—  
oxidation, dehalogenation, biotransformation of metals, biodegradation of solid  
wastes.

### **Microbial Technology for Waste Treatment**

Biotechnological remedies for environmental pollution—decontamination of  
groundwater systems, subsurface environment—reclamation concepts—  
bioremediation. Production of proteins - biofertilizers. Physical, chemical and  
microbiological factors of composting - health risk - pathogens - odour  
management - Microbial cell/enzyme technology - adapted microorganisms -  
biological removal of nutrients - algal biotechnology and applications in agriculture  
- role of extracellular polymers. Biogas technology - case studies.

## **Recombinant DNA Technology and Genetic Application**

Concept of rDNA technology - expression vectors - cloning of DNA - mutation - construction of microbial strains, radioactive probes, protoplast fusion technology - applications.

## **Ethical and Regulatory Issues**

Environmental effects and ethics of microbial technology - safety of genetically engineered organisms - microbial containment - Risk assessment, IPR - patents.

### **References:**

1. Chaudhury, G.R. 'Biological degradation and Bioremediation of toxic chemicals', Dioscorides Press, Oregon, 1994.
2. Martin.A.M, 'Biological degradation of wastes', Elsevier Applied Science, London, 1991.
3. Blaine Metting.F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 1993.
4. Wainwright, M, An Introduction to Environmental Biotechnology, 1999.
5. Old, R.W., and Primrose, S.B., Principles of Gene Manipulation 3<sup>rd</sup> Ed. Blackwell Sci. Publ., Cambridge, 1985.

## **ENV E10: REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATIONS**

### **Objective**

To educate the students on the principles and application of remote sensing and GIS in environmental engineering.

Concepts of Remote Sensing - Principles of remote sensing - Energy sources and radiation principles, Energy interactions with the atmosphere - Spectral reflectance of earth surface features - Data acquisition and interpretation - active and passive aerial photographs - Visible, Infra Red and Microwave sensing - satellite data Products.

Remote Sensing Platforms and Data Processing - Photogrammetry - Satellite data analysis - Visual Interpretation - Digital Image Processing - Image rectification, enhancement classification.

Introduction to GIS - Components of GIS - Data Structure - map - files and data access - data base structure - computer representations of geographical data - Raster - Vector.

Management and monitoring of environment, conservation of resources, coastal zone management - Limitations - urban stormwater studies - solid waste management - optimal routing - wetland studies - non point source pollution - GIS Software - data input and verification - data storage and data base management - data output presentation - data transformation - interaction with user - Digital Elevation Modeling (DEM)

**References:**

1. Lillesand, T.M. and Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, New York, 2004.
2. Burrough, P.A. and McDonnell, R.A., Principles of Geographic Information Systems, Oxford University Press, New York, 2001.
3. Lintz, J. and Simonet, Remote Sensing of Environment, Addison Wesley Publishing Company, New Jersey, 1998.

**ENV E11: MINI PROJECT**

One or two students together will undertake a joint project work addressing a specific problem relevant to issues on Environmental Engineering under the guidance of a faculty from the department. The project should be site specific, involve collection of field data and should ultimately evolve measures to tackle/solve the concerned issues.

The students have to submit the project report at the end of the third semester and the report will be evaluated jointly by an internal examiner and an external examiner through viva-voce examination.



**Annamalai University**  
**Annamalainagar**

**DEPARTMENT OF CIVIL ENGINEERING**

**M.E- Water Resources Engineering & Management**  
**Degree Programme**

**(Choice Based Credit System)**

**SYLLABI**

## Department of Civil Engineering

### SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. (FULL - TIME) DEGREE PROGRAMME IN WATER RESOURCES ENGINEERING AND MANAGEMENT

#### FIRST SEMESTER

Course Code	Name of Course	Period per week				Duration of Exam (Hours)	Marks			Credit units
		L	P	D	S		Exam	Internal Assessment	Total	
WREM 101	Statistical Methods in Hydrology & Water Resources Engineering	4	-	-	-	3	75	25	100	3
WREM 102	Open Channel Hydraulics	4	-	-	-	3	75	25	100	3
WREM 103	Surface Water Hydrology	4	-	-	-	3	75	25	100	3
WREM 104	Ground Water Hydrology	4	-	-	-	3	75	25	100	3
WREM 105	Watershed Management	4	-	-	-	3	75	25	100	3
WREM 106	Elective – I	4	-	-	-	3	75	25	100	3
WREM 107	Advanced Computer Programming Laboratory	-	3	-	-	3	60	40	100	2
	Total	24	3	-	-	21	510	190	700	20

L - Lecture P - Practical D – Drawing S - Seminar

**SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. (FULL - TIME) DEGREE PROGRAMME  
IN  
WATER RESOURCES ENGINEERING AND MANAGEMENT**

**SECOND SEMESTER**

Course Code	Name of Course	Period per week				Duration of Exam (Hours)	Marks			Credit units
		L	P	D	S		Exam	Internal Assessment	Total	
WREM 201	Computational Methods for Water Resources Engineering	4	-	-	-	3	75	25	100	3
WREM 202	Water Resources System Analysis	4	-	-	-	3	75	25	100	3
WREM 203	Remote Sensing & GIS applications in Water Resources	4	-	-	-	3	75	25	100	3
WREM 204	Pipeline Engineering	4	-	-	-	3	75	25	100	3
WREM 205	Soft Computing in Water Resources Management	4	-	-	-	3	75	25	100	3
WREM 206	Elective – II	4	-	-	-	3	75	25	100	3
WREM 207	Remote Sensing & GIS Laboratory	-	3	-	-	3	60	40	100	2
	Total	24	3	-	-	21	510	190	700	20

L - Lecture P - Practical D – Drawing S - Seminar



**SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. (FULL - TIME) DEGREE COURSE IN  
WATER RESOURCES ENGINEERING AND MANAGEMENT**

**THIRD SEMESTER**

Course Code	Name of Course	Period per week				Duration of Exam (Hours)	Marks			Credit units
		L	P	D	S		Exam	Internal Assessment	Total	
WREM 301	Elective – III	4	-	-	-	3	75	25	100	3
WREM 302	Elective – IV	4	-	-	-	3	75	25	100	3
WREM 303	Thesis Phase-I and Viva voce	-	-	-	3	-	60	40	100	6
	Total	8	-	-	3	6	210	90	300	12

L - Lecture P - Practical D – Drawing S - Seminar

**SCHEME OF INSTRUCTIONS AND EXAMINATIONS FOR M.E. (FULL - TIME) DEGREE COURSE IN  
WATER RESOURCES ENGINEERING AND MANAGEMENT**

**FOURTH SEMESTER**

Course Code	Name of Course	Period per week				Duration of Exam (Hours)	Marks			Credit units
		L	P	D	S		Exam	Internal Assessment	Total	
WREM 401	Thesis Phase-II and Viva voce	-	-	-	3	-	60	40	100	13
	Total	-	-	-	3	-	60	40	100	13

L - Lecture P - Practical D – Drawing - S- Seminar

**Electives I – IV will be chosen from the following list of courses**

	<b>Names of Elective Courses</b>
WREM E1	Hydro Power Engineering
WREM E2	Ecology & Environmental Impact Assessment of Water Resources Development
WREM E3	Hydraulic Structures
WREM E4	Ground Water System Planning and Management
WREM E5	Urban Hydrology
WREM E6	Soil and Water Management
WREM E7	River Engineering
WREM E8	Advanced GIS in Water Resources Management
WREM E9	Water Quality Modelling
WREM E10	Water Quality Management for Agriculture
WREM E11	Flood and Drought Management
WREM E12	Ground Water Resources Development and Management
WREM E13	Environmental Systems Management
WREM E14	Advanced Hydrological Analysis and Design
WREM E15	Contaminant Transport
* WREM E16	Mini Project

(\* Offered as an Elective only in Third semester for Full - Time students)

## FIRST SEMESTER

### WREM 101: STATISTICAL METHODS IN HYDROLOGY AND WATER RESOURCES ENGINEERING

Objectives: To emphasize the application of statistical methods in hydrology and water resources engineering. To introduce the statistical tools necessary to solve a wide array of real-world hydrologic-modeling problems.

Introduction to modeling – Statistical decision making – Designation of a model – The modeling process – Computation of moments.

Hypothesis Tests on Means – ANOVA – One-sample and two-sample  $t$  – Tests – Multiple comparisons in ANOVA test – Randomized block design – Two-way ANOVA.

Hypothesis Tests of Variances – One-sample  $\chi^2$  test – Two-sample  $F$  test – Test for group variances.

Frequency Analysis – Procedure – Plotting position formulae – Analysis of selected populations – Fitting normal, lognormal and log-Pearson Type-III distributions – Low frequency analysis – Design-life probabilities.

Non Parametric Methods – One-sample run test for randomness – Tests for serial independence – Test for autocorrelation – Test for trend – Test for distribution inequality – Chi square test for goodness of fit – Kolmogorov-Smirnov one-sample and two-sample tests.

Correlation Analysis – Bivariate correlation – Correlation in multivariate systems.

Bivariate linear regression – Principle of least squares – Reliability of the regression equation – rationality, standard error of estimate, ANOVA, standardized partial regression coefficients.

Reliability of point estimates of regression coefficients – confidence interval of the regression equation – correlation versus regression.

Multiple regression analysis – Matrix solution of the standard model – intercorrelation – criteria for estimating a multiple regression model – coefficient of multiple determination, standard error of estimate, relative importance of predictor variables.

Analysis of residuals.

Polynomial regression analysis – transformation and calibration – ANOVA for polynomial models.

Time Series and Stochastic Modeling – Components of a time series – Moving average filtering – Autocorrelation analysis – Cross correlation analysis – Identification of the random component – Autoregression and cross regression models

## References

1. Richard H. McCuen, Willard M. Snyder, "Hydrologic Modeling: Statistical Methods and Applications", *Prentice-Hall, Englewood cliffs, New Jersey 07632*, 1986 Edition
2. Kottegoda, N.T., "Stochastic Water Resources Technology", *The Macmillan Press Ltd*, 1980 Edition.

## WREM 102: OPEN CHANNEL HYDRAULICS

Objectives: To learn the application of Fluid mechanics in open channel flow, energy and momentum principle equation to analyze the steady and unsteady gradually and rapidly varied flow in rigid boundary channels, develop and apply discharge relations to flow measurement structures and methods to control channel geometry and sediment movement in natural channels.

Gradually Varied Flows: Introductory concepts– Uniform flows– Pressure distributions– specific energy– specific force– Classification and analysis of flow profiles – Computations of flow profiles.

Spatially and Rapidly Varied Flows: Dynamic equation for spatially varied flow– energy and momentum approaches– Methods to compute flow profiles– Flow over spillways, hydraulic jumps, jump over sloping floor, stilling basins – Applications.

Unsteady Flows: Continuity equation- Dynamic equation for gradually varied flow- Uniformly progressive gradually varied flow- Wave profile and wave propagation- Rapidly varied unsteady flow- Moving hydraulic jump- Positive and negative surges- Dam break problem.

Sediment Transport: Sediment properties- Inception of sediment motion- Bed forms- Bed load- Suspended load- Total sediment transport- Design of stable channels and regime channels.

Hydraulic Modeling: Physical modeling of hydraulics- Dimensional analysis- Modeling closed flows and free surface flows- Design of physical models- Numerical modeling in open channel flows.

**References:**

1. Chaudhry, M. H. Open-Channel Flow. Prentice-Hall, Inc. 1993.
2. Chow, V. T. Open-Channel Hydraulics. McGraw-Hill, Inc. (the classic text) 1959.
3. French, R. H. Open-Channel Hydraulics. McGraw-Hill Book Co. 1985.
4. Mays, L. W. editor. Hydraulic design handbook. McGraw-Hill Book Company, 1999.
5. Munson, B.R., Young.D.F. and Okiishi. T.H. Fundamentals of Fluid Mechanics. 1998.

**WREM 103: SURFACE WATER HYDROLOGY**

Objectives: This subject aims at making the students to understand the relevance of various components of hydrologic cycle, which are responsible for spatial and temporal distribution of water availability in any region.

Introduction – Hydrologic cycle – Concept of systems – Hydrologic systems model – Classification of hydrologic models – Reynold's transport theorem – Continuity equations – Momentum equations – Porous medium flow – Energy balance – Transport processes – conduction, convection and radiation.

Atmospheric water – Atmospheric circulation – Water vapour – Vapour pressure – Water vapour in a static atmospheric column – Precipitable water -

Precipitation process – Thunderstorm cell model – Rainfall – Isohyets – Rainfall hyetograph – Areal rainfall – Evaporation – Energy balance method, aerodynamic method, combination method – Evapotranspiration – Reference evapotranspiration – Penman – Monteith method – Crop coefficients.

Sub-surface water – Unsaturated flow – Soil moisture flux – Infiltration – Horton's, Phillip's equations – Green-Ampt method – Ponding time.

Surface water – Streamflow sources – Streamflow hydrograph – Effective rainfall and Direct runoff hydrograph – Abstractions using infiltration equations – SCS method – Travel time of flow on a watershed - Stream networks.

Unit hydrograph – General hydrologic system model – Response function of linear systems – Impulse response function, Step response function and Pulse response function – Linear system in discrete time – Discrete pulse response function – The UH – Derivation – Application of UH – SCS dimensionless hydrograph – Unit hydrographs for different durations – Instantaneous unit Hydrograph (IUH).

Flow routing – Lumped system routing – Level pool routing – Hydrologic river routing – Linear-reservoir model – Distributed flow routing – Saint-Venant's equations – Classification of distributed flow routing models – Wave motion – Kinematic and dynamic wave celerities – analytical motion of the kinematic wave – Finite-difference approximations – Numerical solution of the kinematic wave – Muskingum-Cunge method.

Hydrologic design – Hydrologic design scale – Selection of the design level – Risk analysis – Hydroeconomic analysis – First order analysis of uncertainty – Composite risk analysis.

Design storms – Design depth of precipitation – Intensity-duration-frequency (IDF) relationships – Design precipitation hyetograph from IDF relationships – Estimated limiting storm – Calculation of PMP.

**Reference Books:**

- (1) Ven Te Chow, David R Maidment and Larry W Mays, "Applied Hydrology", McGraw-Hill Book Company, New Delhi, First Edition, 1988.

- (2) Elizabeth M, Shaw, "Hydrology in Practice", *Stanley Thorne (Publishers) Limited*, UK, Third Edition, 1994, Reprinted in 1999.
- (3) Subramanya, K, "Engineering Hydrology", *Tata-McGraw Hill Publishing Company Limited*, New Delhi, 1994 Edition
- (4) Chow V.T., Maidment D.R., Mays L.W., *Applied Hydrology*, McGraw Hill Publications, New York, 1995.
- (5) Raghunath H.M., *Hydrology*, Wiley Eastern Ltd., New Delhi, 1996
- (6) Ven Te Chow, *Hand book of Hydrology*, McGraw Hill Publications, New York, 1995.
- (7) Subramanya K., *Hydrology*, Tata McGraw Hill Co., New Delhi, 1994.
- (8) Vijay P.Singh., *Elementary Hydrology*, Prentice Hall of India, New Delhi, 1994.

### **WREM 104: GROUNDWATER HYDROLOGY**

**Objectives:** The objective of this course is to enable the student to understand the ground water movement and aquifer characteristics. At the end of the course, the student should be able to evaluate the ground water resources and aquifer parameters for different hydro-geological boundary conditions.

**Introduction:** Scope, historical background, utilization of groundwater, groundwater in the hydrologic cycle, origin and age of groundwater.

**Rock properties affecting groundwater:** Geologic formations as aquifers, types of aquifers, porosity, soil classification, specific surface, vertical distribution of groundwater, zone of aeration, zone of saturation, specific retention, specific yield, storage coefficient, springs.

**Groundwater movement:** Darcy's law and its validity, intrinsic permeability, hydraulic conductivity, transmissivity, techniques for determination of hydraulic conductivity, groundwater flow rates, flow nets, flow in relations to ground water contours, flow across a water table, flow across a hydraulic conductivity boundary, dispersion, general flow equations in rectangular and radial co-ordinations.

**Groundwater well hydraulics:** Steady unidirectional flow steady radial flow to a well, unsteady radial flow in a confined aquifer, unsteady radial flow in an



unconfined aquifer, unsteady radial flow in a leaky aquifer, well flow near aquifer boundaries, multiple well systems, partially penetrating wells, characteristic well losses, specific capacity and well efficiency.

Water wells: Test holes and well log; methods for constructing shallow wells and deep wells, well completion, pumping equipment for wells, protection of wells, well rehabilitation, infiltration galleries, horizontal pipes, collector wells.

Groundwater Levels and Environmental Influences: Time variations of levels, stream flow and groundwater levels, fluctuations due to evapotranspiration, meteorological phenomena urbanization, earthquakes, external loads and land subsidence.

**References:**

1. Todd, D.K., "Groundwater Hydrology", John Wiley & Sons, 1980 edition.
2. "Groundwater Manual " , A water resources technical publication, U.S. Department of the interior - 1985 Edition.

**WREM 105: WATERSHED MANAGEMENT FOR SUSTAINABLE DEVELOPMENT**

Objectives: To make the students understand the overall factors influencing watershed development, types of water conservation and harvesting techniques, irrigation management, concept and kinds of participation in watershed development

Introduction: Definition of Watershed – Classification – Basic factors influencing watershed development – Characteristics of watershed – Codification – Watershed based studies – Objectives of watershed management – Watershed work plans – Watershed problems – Socio-economic aspects – Thematic maps of watershed – Land forms and drainage patterns of watershed – Watershed delineation.

Water conservation and harvesting: Types of storage structures – Water yield from catchments – Losses of stored water – Water conservation methods – Water harvesting methods and techniques – Rainwater harvesting – catchment, Harvesting structures, Roof water harvesting – Groundwater potential areas – Groundwater recharge zones – Well construction and maintenance – Conjunctive surface and ground water development – Water quality Management Planning – Watershed

based government programmes – People's participation – Management Plan – Identifications and Evaluations of watershed problems.

Irrigation management: Irrigation development in India – Agriculture – Cropping pattern – Sustainable agriculture – Hybrid and improved seeds – Crop rotation – Organic fertilization – Dry land agriculture – Runoff agriculture – Micro catchment farming – Irrigation with saline water – Reuse water, Sprinkler Irrigation, Drip Irrigation, Pot Irrigation – Reducing cropland percolation and transpiration losses – Selection of water use efficiency crops – Social forestry – Afforestation.

Concept of Participation: Introduction – Dublin statement – Irrigation as a socio-technical process – System management by agencies and users – Farmers organization and participation: need, and contribution to irrigation management (greater productivity, improved water distribution, conflict management, greater resources mobilization and sustained system performance).

Kinds of participation – activities in irrigation management – Water users Association – Types and levels of operation and organization in irrigation systems – User roles in irrigation management – Role of Community organizers – The context of participation: Factors in the environment.

## References

1. Dhuruvanarayana.V.V, Sastry.G and Patnaik.U.S, "Watershed Management", Publications and information division, Indian Council of Agriculture Research, New Delhi, 1990.
2. Murthy J.V.S, "Watershed Management in India", Wiley Eastern Limited, New Delhi, 1995.
3. Ghanshyam Das, "Hydrology and Soil Conservation Engineering", Prentice –Hall of India Pvt. Ltd., New Delhi, 2000.
4. Gelnn O. Schwab, "Soil and Water Conservation Engineering", John Wiley and sons, New York, 1981.
5. Suresh R., "Soil and Water Conservation Engineering", Standard Publishing Distributors, New Delhi, 2000.
6. Mal B.C., "Introduction to Soil and Water Conservation Engineering", Kalyani Publishers, New Delhi, 2002.

7. Tideman E.M., "Watershed Management", Omega Scientific Publishers, New Delhi, 1996.
8. Chambers R., "Managing Canal Irrigation", Oxford IBM Publishing Co., New Delhi 1988.
9. Desai A.R., "Rural Sociology in India", Popular Prakashan, Bombay. 1969.
10. Michel C.M. "Putting People First Sociological variables in Rural Development", Oxford University Press, London. 1985.

#### **WREM 106 : ELECTIVE – I**

#### **WREM 107: ADVANCED COMPUTER PROGRAMMING LABORATORY**

Programming of various Hydrological and Water Resources problems in

1. Statistical Hydrology
2. Time series analysis
3. Hydrological analysis
4. Systems analysis
5. Open Channel flow

## SECOND SEMESTER

### WREM 201: COMPUTATIONAL METHODS IN WATER RESOURCES MANAGEMENT

Objectives: 1. To develop skills in computing techniques and programming as well as the design of hydraulic and hydrological computer models. 2. To improve the computing knowledge of the students for applications in water resources management.

Modeling Principles: Principles of models – Physical, mathematical and digital models – Parameter estimation – Sensitivity analysis – Error in modeling.

Computing Techniques: Concepts of mass energy and momentum conservation – St. Venant unsteady flow equation – Numerical methods – Interpolation – Search techniques – Runge Kutta method applied to free surface profile computation – Finite difference schemes – Methods of characteristics – Fixed and variables grid methods – Finite element methods – Initial and boundary conditions.

Mathematical Concept in Hydraulics and Hydrology: Unsteady flow pipes – Surges – Water hammer – Pipe network in water distribution system – Stream network – Canal automation methods – River basin model – Ground Water Flow model – Mass transport model.

Application of Software in Water Management: Application to water resources using Hydrological Modeling System – Storm CAD – Water CAD – Storm Water model – Aquifer test – Visual Modflow – MATLAB – SIMULINK – QUAL 2E- Agricultural non-point source pollution software (AGNPS) – Case studies.

#### References:

1. Stephen A, Thompson, Hydrology for Water Management. A.A.Balkema Publications, Rotterdam 1999.
2. Vijay P. Singh, Kinematic Wave Modelling in Water Resources – Surface Water Hydrology, John Wiley and Sons Inc. 1996.
3. Linsely R.K. and Franzini J.B., Water Resources Engineering, Mc Graw Hill Book Co.Inc., New York. 1990.

4. Subramania, K., *Open Channel Hydraulics*. Khanna Publications, New Delhi. 2000.
5. Ven Te Chow, *Handbook of Applied Hydrology*. McGraw Hill Book Co. Inc., New York. 1964.
6. Venkateswara Rao and Ramamohan Reddy, *Proceedings of International conference on Hydrology and Watershed Management Volumes 1 and II*. B.S. Publications, Hyderabad. 2002.
7. Bear, J., 1972, *Dynamics of Fluids in Porous Media*, American Elsevier, 764p.
8. Domenico, P.A., and F. W. Schwartz, 1998, *Physical and chemical hydrogeology*, second edition, John Wiley & Sons, 506p.
9. Todd, D. K., 1980, *Groundwater hydrology*, second edition, John Wiley & Sons, 535p.
10. Yeh, G.-T., 1999, *Computational Subsurface Hydrology, Fluid Flows*, Kluwer Academic, 277p.

## **WREM 202 : WATER RESOURCES SYSTEM ANALYSIS**

Objectives: Students will be introduced to application of systems concept to water resources planning and management. Optimization techniques to cover the socio-technical aspects will be taught.

Introduction – Definition of hydrosystems – the concept of systems – Issues in hydrosystems engineering - Characteristics of systems analysis applications – Hydrosystems Economics – Engineering economics analysis – Benefit – cost analysis.

Linear Programming with applications to Hydrosystems – Linear programming (LP) – Forms of LP – Solution algorithms – Simplex method – Cases of the simplex method application - Duality of the simplex method.

Dynamic Programming with applications to Hydrosystems – Elements of a dynamic programming (DP) model – Operational characteristics of DP – Discrete differential Dynamic Programming.

Nonlinear Programming with applications to Hydrosystems – Unconstrained nonlinear optimization – Constrained optimization – Constrained non-linear optimization.

Uncertainty and Reliability Analysis of Hydrosystems – Analysis of uncertainties – Reliability computations using load-resistance analysis – Reliability using time-to-failure analysis – Reliability analysis of simple systems – Optimization of reliability.

Surface Water Systems – Surface water reservoir systems – Storage-Firm yield analysis for water supply – Storage-Firm energy analysis – Reservoir simulation – Optimal sizing and operation of a single multiple-purpose reservoir – Reservoir sizing and operation under hydrologic uncertainty using LP models and DP models - Irrigation planning model – Irrigation operation model.

Flood Control – Flood control alternatives – Flood damage estimation – Optimization model for planning flood control – Optimal selection of flood control alternatives – Reservoir operation models for flood control – Real-time operation of reservoirs.

**References:**

- (1) Larry W Mays and Yeou-koung Tung, "Hydrosystems Engineering and Management", McGraw-Hill Inc., 1992 International Edition
- (2) Daniel P. Loucks, Jery R. Stedinger and Douglas A. Smith, "Water Resource Systems Planning and Analysis", Prentice-Hall, Inc,

**WREM 203 : REMOTE SENSING AND GIS APPLICATIONS IN WATER RESOURCES ENGINEERING**

Objectives: To teach the principles and applications of spatial information technologies namely remote sensing, GPS and GIS in the context of water resources. At the end of the courses the student will appreciate the importance of remote sensing and GIS in solving the spatial problems in water resources.

Spatial data source: Remote sensing, GPS, surveying, topomap and other secondary sources. Physical principle of Remote sensing, classification of Remote sensing system-concepts of microwave remote sensing - Remote sensing platforms- LANDSAT, SPOT, IRS, ERS, INSAT, IKONOS and others – types of aerial photography- methods of viewing aerial photographs- scanning systems – passive and active – Digital processing of Remote sensing data- Image enhancement – Image classification.

Definition- basic components of GIS-standard GIS packages-maps,mapping process, projections, coordinate systems-spatial data –spatial data model-spatial relationship-topology-spatial data structure: raster, vector – attribute data-database-database management systems-database models: Hierarchical, network, relational, object oriented models-data input, editing-integrated GIS database.

Thematic mapping-measurement in GIS: length, perimeter and areas- Query analysis-Reclassification-Buffering-Neighbourhood functions-Integrating data: map overlay, overlay functions, vector overlay and raster overlay – Interpolation-Network analysis-Data output types- Output devices-Error- Types of errors.

Application of Remote sensing: Evaluation of water resources- water penetration and depth measurement- water quality-water temperature-soil

moisture-study of Geology, geomorphology, drainage, morphological and land use\land cover of watersheds-groundwater resources.

Application of GIS: Base map preparation-catchment survey-regional rainfall mapping-surface water resources- Inventory-groundwater potential mapping-site selection for artificial recharge- reservoir sedimentation- water quality mapping-National, regional and local water resources planning.

## References

1. Lillesand, T.M. and Kiefer, R.W., Remote Sensing and Image Interpretation III Edition. John Wiley and Sons, New York. 1993.
2. Burrough P.A. and McDonnell R.A., Principles of Geographical Information System, Oxford University Press. New York. 1998.
3. Bernhardesen. T., Geographic Information Systems: An Introduction, John Willy and Sons, inc. 1999.
4. Ian Heywood Sarah, Cornelius and Steve Carver An Introduction to Geographical Information Systems. Pearson Education. New Delhi. 2002.
5. Lo,C.P. and Yeung, A.K.W., Concepts and Technologies of Geographic Information System, Prentice-Hall of India, New Delhi. 2004.

## WREM 204: PIPE LINE ENGINEERING

Objectives: To introduce the students the concepts and various methods of network analysis in transportation of water.

Introduction – types of water supply systems, piping systems, water distribution networks – labeling network elements – network components – network model – basic hydraulic principles.

Network parameters and types of analysis: Network parameters – Parameter interrelationships – Necessity of analysis – Types of analysis – Rules of solvability of pipe networks – Formulation of equations – single source and multi source networks – Handy cross method – Newton – Raphson method – Linear theory method – Gradient method and other analysis methods.



Dynamic analysis: Interactive method, Direct method – Analysis considering withdrawal along links – Head dependent analysis and Network Performance Two – demand node serial Network – Performance based analysis – Practical applications.

Node flow analysis: Classification of Nodes – NFA theory – Problem formulation, problem solution and solution procedure – Practical applications.

Water Quality modeling: Model development – Hydraulic models – Chlorine transport – chlorine decay – Mixing in distribution network – Chlorine concentration prediction – Static and dynamic models for chlorine concentration.

Network calibration – Data collection and preparation – calibration methods – practical considerations.

Fuzzy parameters and Network analysis – Parameter interrelationships – Membership function of dependent parameters – sensitivity analysis – unsteady flow analysis – Reliability analysis – Computer application and software packages.

## **References**

1. Bhave P.R and Gupta R (2008) Analysis of 'Water Distribution Networks' Narosa Publishing House, New Delhi.
2. AWWA (1996), Water transmission and distribution, second edition, Principles and Practices of water supply operation series, American water works Association.
3. Bhare. P.R (2003) 'Optimal Design of Water Distribution Networks', Narosa Publishing Home, New Delhi.

## **WREM 205 : SOFT COMPUTING IN WATER RESOURCES MANAGEMENT**

Introduction: Basic concepts of Neural Networks and Fuzzy Logic, Difference between conventional computing and Neuro –Fuzzy computing, Characteristics of Neuro Fuzzy Computing.

Fuzzy Set Theory: Basic definitions and terminology and membership functions – formulation and parameters, basic operations of fuzzy sets – complement, intersection, union,  $\cap$  – norm and  $\cup$  – conorm.

Fuzzy Reasoning and Fuzzy Inference: Fuzzy rules, Fuzzy reasoning, Fuzzy Inference Systems, Fuzzy modeling, Applications of Fuzzy reasoning and modeling in Civil Engineering Problems.

Fundamental concepts of Artificial Neural Networks: Model of a neuron, activation functions, neural processing, Network architectures, learning methods.

Neural Network Models: Feed forward Neural Networks, Back propagation algorithm, Applications of Feed forward networks, Recurrent networks, Hopfield networks, Hebbian learning, Self organizing networks, unsupervised learning, competitive learning, Neuro-fuzzy computing: Hydrologic Modelling Time series Analysis and Modelling, Water Management.

Basic concepts of other soft computing algorithms – Genetic algorithms – Evolutionary algorithms – simulated Annealing – honeybee mating algorithms – Applications to water resources engineering problems.

### **References:**

1. Jang, JSR, C.T. Sun and E. Mizutani (1997), "Neuro-Fuzzy and Soft Computing", Prentice Hall, NJ.
2. Simon Haykin, (1994), "Neural Networks, A Comprehensive Foundation", McMillan College Publishing Company.
3. Kosko, B. (1997), "Neural Networks and Fuzzy Systems", Prentice Hall of India Pvt. Ltd., New Delhi.
4. Klir, George J., T.A. Forger, (1995), "Fuzzy Sets, Uncertainty and Information", Prentice Hall of India Pvt. Ltd., New Delhi.
5. Rao V and H. Rao, (1996), "C++ Neural Networks and Fuzzy Logic, BPB Publications, New Delhi.

## **WREM 206 : ELECTIVE - II**

### **WREM 207: REMOTE SENSING AND GIS LABORATORY**

Remote Sensing Laboratory: Familiarization with pocket, mirror and prism stereoscopes – Marginal Information of aerial photograph – Height measurement (i) Monoscopic measurement (ii) Stereoscopic measurement – Slope measurement – Referencing system of various resource satellite images – Marginal information of satellites images – Constructing spectral reflectance curves – Interpretation of Thermal images – Interpretation of Radar images.

GIS Laboratory: GPS – map projection – Transformation – Different data format – Creating spatial data – Attribute data entry – Spatial analysis – Reclassification – Overlay analysis – Interpolation – Digital Elevation model – Project works.

### **ELECTIVE COURSES**

**(WREM 106, WREM 206, WREM 301 & WREM 203)**

#### **WREM E1: HYDRO POWER ENGINEERING**

Objectives: To show the Importance of hydro-power projects - power plants, various components of hydropower plants, their layout and design planning and design of prepped storage plants and other types of power plants.

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

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

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

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

Tail Race: Functions, types (channel and tunnel). Draft tubes, function and principle types. Pumped storage plants: Concepts, general layout, types and economics. Tidal power stations: Concepts, general layout, classification, and types. Other types of power plant: Depression power plant. Micro power station - Need for the development and the problems faced.

## **References**

1. Mosonyi, E. - Water power Development Vol. I, 1964 and Vol. II, 1970
2. Brown, G. et al. – Hydro - Electric engineering practice Vol. I, II & III, 1984
3. Jog. M.G., Hydro - electric and pumped storage plants, wiley Eastern, New Delhi, India, 1989
4. Dandekar M.M. - Water Power Engineering, Vikas Pub. House Pvt. Ltd, 1979
5. Varshney, R.S., Hydro Power Structures - Nem Chand Bros. Roorkee, 1973.
6. Varshrey, D.V. and Varshney, M. (1987). Design of Hydraulic structures, New Delhi: Khana publishers

## **WREM E2: ECOLOGY AND ENVIRONMENTAL IMPACT ASSESSMENT OF WATER RESOURCES DEVELOPMENT**

Objectives: To introduce the concepts of ecology and biological aspects of environment, and to assesses necessary skills to assess the impact of water resources development on the environment as well as to deal with the associated problems.

Environmental Issues: Water resources development and environment issues – Environment in water resources project planning – Environmental regulations and requirements – The EIA) Environmental Impact Assessment) notification.

Systems Ecology: Concept of ecology – Ecosystem structure and function – Food chain and food webs – Concepts of community and carrying capacity – Biodiversity – Characteristics of freshwater environment.

Environmental Impacts: Hydrological and water quality impacts – Ecological and biological impacts – Social and cultural impacts – Soil and landscape change – Agro economic issues – Human health impacts – Ecosystem changes.

Methods of EIA: EIA team formation – Development of scope, mandate and study design – Base line survey – Check lists – Adhoc procedures – Network and matrix methods – semi-quantitative methods – ICID checklist – Economic approach – Environmental Impact Statement (EIS) preparation.

Environmental Management: In-stream ecological water requirements – Public participation in environmental decision making – Sustainable water resources development – Eco-restoration – Hydrology and global climate change –Human ecology – Ecosystem services – Environmental monitoring programs.

### **References:**

1. Center, L.W., Environmental Impact Assessment. McGraw Hill International Edition, New York, 1995.
2. Barathwal, R.R., Environmental Impact Assessment. New Age International Publishers, New Delhi, 2002.
3. Odum, E.P., Basic Ecology, Saunders & Co., Philadelphia, 1984.
4. Arnel, N., Hydrology and global environmental change. Prentice Hall, Harlow, 2002.

### **WREM E3: HYDRAULIC STRUCTURES**

Objectives: To provide planning and engineering design concepts and their application to various structures in hydropower projects including turbines and other structures.

Reservoir Planning: Classification of reservoirs, storage zones of a reservoir, fixing capacity of reservoirs, life of a reservoir.

Dams: Investigation surveys, selection of dam site, selection of types of dam, classification of dams. Gravity Dams Forces acting on dam, combination of forces for design, design parameters, design of gravity dam, profiles of a dam, stability analysis, foundation treatment, galleries in gravity dams.

Earth and Rock fill Dams: Types, design criteria for earth dams, design consideration in seismic region, phreatic line, flow net, stability analysis, methods of analysis, slope protection, seepage, dam section to suit available materials and foundation, causes of failure of earth dams, safety measures.

Spillways: Components factors affecting type and design of spillway, types, energy dissipation below spillways, hydraulic jump type stilling basins spillway gates, types.

Weirs and Barrages: Design of impervious floor on pervious foundation. Bligh's Lane's creep theories, potential theory cut offs, weir design, Khosla's method.

Unlined irrigation channels: Design parameters, transmission losses, determination of water losses, design formulae, Kennedy's and Lacey's theories, channels on non-alluvial soils.

#### **References:**

1. R.K. Sharma, "Text Book of Irrigation Engineering and Hydraulic Structures ", - Oxford & IBH, 1984
2. C. Satyanarayana Murthy, "Design of Minor Irrigation and Canal Structure" - Wiley Eastern, 1990.
3. S.K. Sharma, "Design of Irrigation Structures", S.Chand & Co, 1988.

## **WREM E4: GROUNDWATER SYSTEM PLANNING AND MANAGEMENT**

Objectives: This course provides the fundamental know-how on groundwater flow and transport processes, Sources of pollution, techniques for groundwater resources assessment, environmental issues of overcharging and overexploitation of groundwater development, management of groundwater resources development and groundwater pollution.

Introduction – An overview of groundwater systems – Model formulation and development.

Groundwater flow equations – Darcy's Law – the Continuity equation – Partially saturated flow – Partially unsaturated flow – Conservation of mass in a deforming porous medium – Groundwater flow equations for a confined or leaky aquifer and unconfined aquifer.

Groundwater quality – the mass transport problem – Mass transport equation – Groundwater quality model – Vertically averaged mass transport equations – Boundary and initial conditions – Non conservative processes – Partially saturated flow systems.

Numerical methods in Groundwater Management – the response equation – Finite difference numerical models – Finite element models – the method of weighted residuals – Solution methods for the dynamic response equation – Non linear systems – Matrix method for the solution of linear system of equations – Finite difference stability analysis – Finite element analysis.

Optimization methods for Groundwater Management – Preliminaries of mathematical programming – Linear programming – Stochastic linear programming – Quadratic programming – Dynamic programming – Stochastic dynamic programming – Non linear programming – Unconstrained optimization – Constrained optimization – Multi-objective programming.

Groundwater Supply Management Models – Groundwater allocation model – Groundwater operation model – Capacity expansion model – Conjunctive groundwater and surface water planning model.

Groundwater Quality Management Modeling – Groundwater quality simulation models – Solution methods for the groundwater quality prediction problem – Optimal groundwater quality management model – Solution algorithms for the conjunctive management model.

The Inverse Problem in Groundwater Systems – Parameter estimation problem – Parameter dimension and parameterization – Parameter identification methods – Equation error criterion – Parameter estimation model – Output error criterion parameter estimation model – Gauss-Newton algorithm – Computation of sensitivity coefficients – Parameter uncertainty and optimum parameter dimension – Bayesian estimation – Statistical methods.

#### **References:**

- (1) Robert Williams and William W-G. Yeh, "Groundwater System Planning and Management", Prentice – Hall Inc., 1987 Edition.
- (2) Dantzig, G.B., Linear programming and extensions, Princeton University Press, Princeton, New Jersey, 1963.
- (3) Huyakorn, P.S. and Pinder, G.F., Computational methods in subsurface flow, Academic Press
- (4) Lee, S.M., Linear optimization for management, Petrocelli/ Charter, New York, 1976.
- (5) Remson, I., Hornberger, G.M. and Molz, F.J., Numerical methods in subsurface Hydrology, Wiley-Interscience, New York
- (6) Rushton, K.R., Redshaw, S.C., Numerical analysis by analog and digital methods, John Wiley and sons

#### **WREM E5: URBAN HYDROLOGY**

Objectives: To introduce to the concepts of urbanization and its impact on the natural water cycle. At the completion of the course, the student should be able to apply appropriate management techniques for planning, operating and maintaining the different components of urban and drainage system.



Urban hydrologic cycle: Water in the urban eco-system - Urban water resources - Major problems – Urban hydrological cycle - Storm water management objectives and limitations - Storm water policies - Feasibility consideration.

Urban Water Resources Management Models: Types of models - Physically based - conceptual or unit hydrograph based -Urban surface runoff models - Management models for flow rate and volume control rate - Quality models.

Urban Storm Water Management: Storm water management practices (Structural and Non- structural Management measures) - Detention and retention concepts – Modelling concept - Types of storage - Magnitude of storage - Hydraulic analysis and design guidelines - Flow and storage capacity of urban components - Temple tanks.

Master plans: Planning and organisational aspects - Inter dependency of planning and implementation of goals and measures - Socio - economics financial aspects - Potential costs and benefit measures - Measures of urban drainage and flood control benefits - Effective urban water user organizations.

Operation and Maintenance: General approaches to operations and maintenance - Complexity of operations and need for diagnostic analysis - Operation and maintenance in urban water system - Maintenance Management System - Inventories and conditions assessment - Social awareness and involvement.

## **References**

1. Geiger.W.F., Marsalek.F., Rawls.W.J., and Zuidena.F.C., (Ed), manual on drainage in urbanized areas - Vol.I and Vol.II, UNESCO, 1987.
2. Hengeveld H. and C.DeVoch.t (Ed)., Role of Water in Urban Ecology., 1982.
3. Martin P.Wanelista and Yousef A.Yousef., Storm Water Management, John Wiley and sons, 1993.
4. Neil S.Grigg., Urban Water Infrastructure planning, management and Operations, John Wiley and Sons, 1986.
5. Overtens D.E. and Meadows M.E., Storm Water Modelling, Academic Press, New York, 1976.

## **WREM E6: SOIL AND WATER MANAGEMENT**

Objective: This course aims at making the students to understand the physical and chemical properties of soil, their significance in soil fertility and water management for crop growth, soil-water-plant interaction, methods of irrigation, crop water requirements and agronomic measures to improve water use efficiency.

Soil – Definition – Major components of soil – mineral matter – soil separates – physical properties of soils – texture and structure – importance in water management – chemical properties of soils – chemical composition – soil interaction.

Soil organic matter – importance of soil fertility and water management – major soil types – degraded soils, problem soils and their management – water – hydrologic cycle – its unique properties – kinds of soil water – adhesion – cohesion – movement of water in the soil – role of water in plant growth.

Soil moisture constants – saturated and unsaturated flow – availability and absorption by roots – measurement of soil moisture – moisture stress – excess soil moisture and crop growth – measurement of irrigation water – various devices.

Principles of Agronomy and Crop Production.

Origin, adaptation and distribution of crops – influence of genetic and environmental factors on crop growth – Role of agronomy – Growth stages of crops - Competition in plant communities – biological and economic yield – Yield components – Cropping systems – Tillage – seed treatment and nursery practices – Density and plant arrangement – Nutrient management – weed management – Plant protection, including the concept of Integrated Pest Management (IPM).

Crop Production Practices

Seasons of cropping and production practices for crops of importance in Tamil Nadu: cereals and millets; grain legumes; oilseed crops; and cash crops such as sugarcane, cotton, banana and coconut.

## References

1. Brady N.C., The nature and Properties of soil. Prentice-Hall of India Pvt. Ltd. New Delhi. 1995.
2. ICAR, hand Book of Agriculture. Indian Council of Agricultural Research, New Delhi. 1999.
3. Chapman S.R. and carter L.P., Crop Production Principles and Practices, W.H. Freeman and Co., New York. 1976.
4. Morachan Y.B., Crop Production and Management. Oxford and IBH Publishing Co., New Delhi. 1984.
5. DOA Crop Production Guide. Directorate of Agriculture, Government of Tamil Nadu, Chepauk, Chennai. 1999.

## WREM E7: RIVER ENGINEERING

Objectives: to provide the concept of river basin and river engineering- To study the impact of land use changes, sedimentation, hydrologic extremes on basin morphology. To introduce the concept of the wet lands and coastal hydrology.

River Engineering: River Basin concept – Multisectoral users – Integrated water use planning – Watershed topology – Stream network – Drainage density – Classification of rivers – Regime theory – Meandering – Cutoff –Effect of reservoir on river regime – River training measures- Bank protection – Flood waves and river diversion.

Sedimentation: Soil erosion – Shear velocity – Bed load – Suspended load – Density current – Trap efficiency – Reservoir sedimentation and its pattern – Life of reservoir – Flood – Minimum flow.

Impacts: Impact of land use changes in basin morphology – Impact of drought and floods – Watershed changes on quantity and quality of water.

Wet lands: Presence of lakes and tanks – Marshy land – Types of wet lands (fresh water / coastal / marine) – Functions of wetlands – Pollution – Ecosystem processes.

Coastal Hydrology: Coastal Zone – Delta – Precipitation in coastal area – Cyclone – Disaster mitigation – Drainage congestion – Effect of tidal waves on drainage – Groundwater development in coastal zone – Sea water intrusion – Importance of estuary and coastal wet lands – Nutrient enrichment in coastal waters – Coastal pollution.

### **References**

1. Eagleson Peter. S. Dynamic Hydrology, Mc Graw Book Company, New York, 1970.
2. Janson P.Ph., Bedegon. Van den J., Vriesde M., Zanen A., Principles of River Engineering, Pitman Publishing Ltd., 1979.
3. Natarajan R., Dwivedi S.N., Ramachandran S., Coastal Zone Management, Ocean Data Centre, Anna University, 1991.
4. Punmia B.C., Pande BB lal, Irrigation and Water Power Engineering, 12<sup>th</sup> edition reprint, Laxmi Publications Ltd., New Delhi, 1997.

### **WREM E8: ADVANCED GIS IN WATER RESOURCES MANAGEMENT**

Objective: To teach advanced GIS analysis and its applications to hydrological modelling and water resources management. 2. To give hands on training in the use of GIS packages.

Advanced GIS Analysis: Analytical Hierarchy Process, Digital Terrain Modelling – Digital Elevation Model (DEM) – Methods- Object oriented GIS – AM/FM/GIS-Virtual GIS- Web Based GIS – Artificial Natural Network, Fuzzy Logic –Spatial Decision Support System- Case studies with water resources applications.

GIS Data Quality: Data quality – Terminology, Common sources of error – Components – Micro level components – Positional accuracy, Attribute accuracy, Logical consistency, Resolution; Macro level components- Completeness, Time and lineage, Usage level components – Accessibility of data – Direct and indirect cost of data – Meta data – Spatial data transfer standards.

GIS in Hydrological Modelling: Hydrological modelling – Empirical modelling – Conceptual modelling – Physically based models – Lumped model – Distributed model – Linking GIS and hydrological models – Rainfall – Runoff modelling- Groundwater modelling – Soil erosion modelling – Water quality modelling.

GIS in Water Resources Management: Flood inundation – Flood plain zone management – Drought monitoring – Drought information system – Inter and intra basin transfers in Indian Rivers- Water conservation – River basin management.

GIS Irrigation Water Management: Baseline survey of irrigation projects – Estimation of crop water requirement – Irrigation scheduling – Cropping pattern change analysis – Command Area Information System – Performance evaluation of irrigation commands.

GIS Laboratory: GPS – Map projection – Transformation – Different data format- Creating spatial data – Attribute data entry – Spatial analysis – Reclassification – Overlay analysis – Interpolation- Digital Elevation Model – Project work.

## **References**

1. Burrough P.A and McDonnell R.A., Principles of Geographical Information Systems. Oxford University Press, New York. 1998.
2. Goodchild, M.F., Parks, B.O., and Steyaet, L.T., 'Geographic Information Systems and Environmental Modeling', Oxford University Press, New York, 1993.
3. Centre for Water Resources, 'Change in Cropping Pattern in Drought Prone Chittar sub-basin', Project Report, Anna university, Chennai, 2002.

## **WREM E9: WATER QUALITY MODELLING**

Objectives: To provide basic knowledge and understanding of mathematical modelling including numerical methods in modelling of water resources engineering problems and non-point pollution sources .

Introduction to mathematical modeling – Simulation-Optimization- examples - Computer Aided Design - Introduction to Numerical Methods - Systems of Simultaneous Equation - Finite difference approximations to differential equations – Partial Differential Equations.

Models of water quality in rivers – convective differential equation – Molecular diffusion and Fick's law - River Models-Analytical and Numerical Solutions – Dissolved Oxygen Sag - Lagrangian Models - Operational Model-Optimization Model- Models of discharge.

Lake and Reservoir Modeling - Factors affecting Water Quality in Lakes - Lake Models -Models of Water quality in Estuaries – Estuarine Hydraulics – Estuarine Models- Finite Difference Models – Surveys and Data requirements.

Ground water Quality Modeling-Governing equations of ground water hydraulics-Analytical solutions-Mass transport.

Mathematical model of the discharge of wastewater into a marine environment-Initial dilution in the buoyant jet-Diffusions of neutrally buoyant jet in an ocean current.

#### **References:**

1. James, A. (ed) An introduction to Water Quality Modeling, John Wiley and sons, New York, 1984.
2. Biswas, A.K (ed) Systems Approach to Water Management, McGraw Hill, New York, 1976.
3. Rinaldi, S. et.al, Modeling and Control of River Water Quality, McGraw Hill, New York, 1979.
4. Bean, J . Dynamics of Fluids in Porous Media Elsevier, New York, 1972.

#### **WREM E10: WATER QUALITY MANAGEMENT FOR AGRICULTURE**

Objectives: Students will be introduced to soil-water plant relationship from the context irrigation water management. At the Completion of the course the students would have learnt about irrigation systems in general, and irrigation scheduling, irrigation water distribution, and design and evaluation of irrigation methods, in particular.

Water quality evaluation – Water quality problems – Approach to evaluating water quality – Water quality guidelines - Salinity problem – Build up of soil salinity - salinity effects on crops – Management of salinity Problems.

Infiltration problems – Problem evaluation – Management of infiltration problem – Soil and water amendments – blending water supplies – Cultivation and deep tillage – Irrigation management.

Toxicity Problems – Specific ions and their effects – Management of toxicity problems – leaching – Crop selection – Cultural practices – Blending water supplies – Toxicity effects due to sprinkler Irrigation.

Miscellaneous Problems – Excess Nitrogen – Abnormal pH, Scale deposits – Magnesium problems – Trace elements and their toxicity – Nutrition and water quality – Clogging problems in localized drip irrigation systems – Corrosion and incrustation – Vector problems.

Experiences using water of various qualities – Reuse of agricultural drainage water – High carbonate water used for overhead sprinkler irrigation – High salinity water use – Use of marginal quality water – Agricultural use of treated waste – Wastewater irrigation.

#### **References:**

1. Ayers, R.S. and Westcott,D.W, FAO Irrigation and Drainage paper – 29 (Revised), FAO, Rome, Italy, 1985
2. Salinity Seminar Baghdad – FAO Irrigation and Drainage paper –7, FAO, Rome, Italy, 1971.
3. Irrigation Practice and Water Management FAO Irrigation and Drainage paper –1 (Revised), Rome, Italy, 1971.

### **WREM E11: FLOOD AND DROUGHT MANAGEMENT**

Objective: This course aims at making the students understand the hydrologic extreme namely, drought, estimation of severity and extent of damages and the mitigation measures to combat it.

Objective: This course aims at making the students understand the hydrologic extremes namely, floods and droughts, estimation of severity and extent of damages and the mitigation measures to combat them.

Methods of estimation of flood discharge frequency – stage–frequency curves – design storm – design flood.

Methods of controlling floods – dams, storage reservoirs, levees, improved channel ways, flood ways – flood plain zoning – Non-structural methods of flood damage reduction – flood proofing, flood forecasting, flood warning and flood fighting.

Definitions based on rainfall, stream flow, vegetation and comprehensive aspects – Characterization of drought/water shortage/aridity/desertification – NCA classification – Direct and indirect losses.

Drought indices – Drought severity assessment – meteorological, hydrological and agricultural aspects – IMD, Palmer, Herbst, Aridity Indices and Ramaprasad Methods.

Drought monitoring – Supply and demand oriented measures – Traditional water conservation – Drought Prone Areas Programme (DPAP) – Integrated drought management – Remote sensing applications for drought mitigation – NDVI concepts.

#### **References:**

1. Vijay P. Singh., Elementary Hydrology, Prentice – Hall India Pvt. Ltd., New Delhi, 1994
2. Chow, V.T., Maidment, D. R., and Mays, L.W., 'Applied Hydrology', McGraw-Hill Publishing Company, New York, 1995.
3. Rangapathy V., Karmegam M., and Sakthivadivel R., Monograph in Flood Routing Methods as Applied to Indian Rivers, Anna University Publications, 1988.
4. Yevjevich, V., Drought Research Needs, Water Resources Publications, Colorado State University, USA, 1977.



## **WREM E12: GROUND WATER RESOURCES DEVELOPMENT AND MANAGEMENT**

Objectives: To explore the various surface and sub surface investigation methods for groundwater resources evaluation; To highlight the various management techniques in ground water flow analysis.

Evaluation of Ground water Resources - types of aquifers, safe yield - factors affecting safe yield - method of estimating safe yield surface geophysical methods - electrical resistivity method - seismic method - subsurface investigation - test drilling - resistivity logging - application of remote sensing method.

Groundwater Flow Analysis: Basic potential theory - irrationality uniform, source, sink, doublet and their contributions (Two dimensional analysis only) Half body - applications in groundwater flow - numerical methods - finite, difference method - physical models - hele shaw apparatus.

Groundwater quality - chemical constituents in atmospheric precipitation, soil and plant effects - aquifer effects - groundwater constituents, water quality standards and suitability for drinking, industry and irrigation uses, water quality analyses - corrosion in tube wells.

Conjunctive use - groundwater recharge sea water interusion - land subsidence.

### **References:**

1. Vallentine, H.R. Applied Hydrodynamics, Butterworth, 1959.
2. Todd, D.K., "Groundwater Hydrology", John Wiley & Sons, 1980 edition.
3. Robert Williams and William W-G. Yeh, "Groundwater System Planning and Management", Prentice – Hall Inc., 1987 Edition.

## **WREM E13: ENVIRONMENTAL SYSTEMS ENGINEERING**

Objective: To emphasize the various physical, chemical and Biological Phenomena applicable to Environmental Systems Engineering. To expose the students to different ecological systems and natural transport systems.

Physical Phenomena: Transport, Gas Transfer, thermal Phenomena, Sedimentation, Continuous Flow Models.

Chemical Phenomena: Solution Equilibriums, Reaction Kinetics, Carbonate Equilibriums, Thermochemistry, Colloidal Behaviour.

Biologic Phenomena: Organic Materials, Microorganisms, Growth Kinetics, Biochemical Oxygen Demand, Anaerobic Decomposition, Photosynthesis, Food Chains.

Ecological Systems: Models, Analytical Solutions, Time Domain Simulation, Continuous Flow Microbiological System, Pesticide Concentration, Eutrophication.

Natural Transport Systems: Basic Models, Dissolved Oxygen System, Streams, Estuaries, Transport in the Air Environment.

Planning Factors: Water Quality Criteria and Standards, Air Pollution and its Control, Radiological Health, Environmental Impact Statements, Population Growth Models, Regional Growth Model, Time Capacity, Expansion of Systems.

Engineered Transport Systems: Pipe Network Analysis, Water Distribution Systems.

Water Treatment Systems: Treatment drains, Lagoon Systems Individual Household Systems.

**References:**

1. Rich, L.G. (1973) "Environmental Systems Engineering", McGraw Hill Inc.
2. Sincero, A.P. and Sincero, G.A. (1999) "Environmental Engineering –A Design Approach:", Prentice Hall of India, NewDelhi.
3. Peavy H.S. Row D.R. and Tchobanaglou G (1995) "Environmental Engineering", McGraw Hill International Edition.
4. Hammer M.J. and Hammer M.J. Jr. (1996), "Water & Wastewater Technology", Prentice Hall of India, NewDelhi.

## **WREM E14: ADVANCED HYDROLOGIC ANALYSIS AND DESIGN**

Objectives: to enhance the analysis of hydrological events and design hydrological modeling. To study the prediction and forecasting the hydrological data through deterministic and stochastic as well as time series analysis.

Hydrologic Models: Hydrologic Information – System Approach – Concept of Model – Classification of Hydrological Models.

Hydrologic Models: Time of Concentration – Time area Methods- Instantaneous Unit Hydrograph- Clark Model- Nash Model- Tank Model- V.C.Kulandaisamy model – Case studies.

Simulation Models: Deterministic and Stochastic Models- Event Based stream flow Stimulation models- Continuous stream flow Stimulation models- Application and Case studies.

Time Series Analysis: Components of time series- Trend Analysis- Regression – Stepwise - Multiple Linear- Single exponential smoothing- Diagnostic tools- Risk Analysis.

Forecasting Models: Box Jenkin's models- Correlation- Auto correlation- Partial auto correlation- Yule Walker equation- AR(p)-MA(q)- ARMA(p,q)- ARIMA(p,d,q) Models - Model formulation- Validation- Application.

### **References**

- 1 Vijay P.Singh, Elementary Hydrology, Prentice Hall of India, New Delhi, 1994
- 2 Jayarami Reddy P, Stochastic Hydrology, Laksmi Publications, New Delhi, 1995
- 3 Makaidakis, Mc Gee and Wheel Wright, Forecasting methods, John Wiley and Sons, New York, 1992

## **WREM E15: CONTAMINANT TRANSPORT**

Objectives: To make the students understand the different methodologies for contaminant transport modeling with emphasis on groundwater; to introduce the various software codes available for various solution schemes in contaminant transport modeling.

Review of Groundwater Principles: Aquifer Properties – Darcy's Law – Principal Directions – Partial Differential Equation (PDE) for Groundwater Flow.

PDE for Mass (contaminant) Transport: Hydrodynamic dispersion – Advective Transport – Advection Dispersion Equation – Principal Directions – Conservative versus Reactive Transport.

Numerical Groundwater Contaminant Transport Modeling: Finite difference Method (FDM): Numerical dispersion – Stability analysis – Implicit and Explicit Finite difference solutions – Mixing Cell Approach.

Method of Characteristics (MOC): Characteristics Equations – Particle Tracking solutions - Stability Considerations – Advantages and Disadvantages.

Random Walk Method (RWD): Theoretical Basis – Advantages /Disadvantages Finite Element Method (FEM) - Modified Method of Characteristics (MMOC) - Total Variation Diminishing (TVD) Method.

Analytical Solutions: Transformed Advection/Dispersion Equation – Fundamental solution – Continuous Point Solution – Instantaneous Line Solution – Normal Distribution of Contaminants.

Major Numerical Modeling Codes: Modflow Companion Models: MT3D (Modular 3D Transport) – RT3D (Reactive 3D Transport) – SEAWAT (Seawater intrusion)

USGS Codes: MOC (Method of Characteristics) – Bio MOC (MOC Biodegradation Reactions) – Other – PHAST (Multicomponent Geochemical reactions) – SUTRA (Variable Density Variable Saturation) – VS2DT (Variable Saturated 2d Transport) – RUNSAT (Reactive Unsaturated).

EPA/CMOS Codes: Bio Plume (Oxygen limited biodegradation) – MOFAT (Multiphase Multicomponent Transport).

Modeling Chemical Reactions: Types of Geochemical Reactions – Adsorption – Desorption Reaction – Freundlich Isotherm – Radioactive Decay – Hydrolysis – Equilibrium Reactions and Law of Mass Action – Microbial Degradation – Modeling Multi Component contaminant Transport.

Natural Attenuation / Intrinsic Bioremediation: Bioremediation of petroleum hydrocarbons – Electron Acceptors/ Donors – Bioavailability – Equilibrium Chemical reactions Technical Protocol for Implementation.

Soil/ Groundwater Remediation Systems: Soil Vapor Extraction (SVE) – Air Sparging Systems (AS) – Pump and treat Systems (PT).

## References

1. Applied contaminant transport Modeling, 2<sup>nd</sup> edition by Chunmiao Zheng and Gordon D. Bennett, 2002, Wiley Interscience
2. Flow and Transport in Porous Formations by Gadeon Dagan, 1989, Springer Verlag
3. Groundwater Contamination Transport and Remediation by Phillip Bedient, Handadi Rifai, and Charles Newell, 1999, Pretice Hall
4. Contaminant Hydrology, 2<sup>nd</sup> edtion by C.W. Fetter, 1998, Prentice Hall
5. Groundwater Hydraulics and Pollutant Transport Randall Charbeneau, 2000, Prentice Hall
6. Bioremediation and Biodegradation, 2<sup>nd</sup> edition by Martin Alexander, 1999, Academic Press
7. Natural attenuation of Fuels and Chlorinated solvents in the Subsurface by Todd Widemeier, Handai Rifai, Charles Newell, and John Wilson, 1999, Wiley
8. The soil Chemistry of Hazardous materials, 2<sup>nd</sup> edition by James Dragun, 2001, Hazardous materials Control Research Institute

## WREM E 16: MINI PROJECT

One or two students together will undertake a joint project work addressing a specific problem relevant to issues on water resources engineering under the guidance of a faculty from the department. The project should be site specific,

involve collection of field data and should ultimately evolve measures to tackle/solve the concerned issues.

The students have to submit the project report at the end of the third semester and the report will be evaluated jointly by an internal examiner and an external examiner through viva-voce examination.

**Model Question Paper for each Programme in Year wise is enclosed in folder as: ANNEXURE - I**

**V. Departmental Research Programmes : UGC- SAP/ DST-FIST/Others (specify)**

The Department is placed under UGC-SAP – DRS Level-I



**VI. Research Projects: Above Rs. 50.00 Lakhs Rs. 5 to 50 Lakhs Less than Rs. 5 Lakhs**

<b>Title of the Project</b>	<b>Funding Agency</b>	<b>Duration of the project</b>	<b>Total Outlay Rs.</b>
Mapping of Crop Co-efficient for South India. (Dr. A. Murugappan)	AICTE	3 Years (2003-2008)	Rs. 5,00,000/-
Estimation of Exponent Value of Power Exponent Values of Power Law for Neyveli & its extension to other parts of India. (Dr. M. Rajendran)	UGC	3 years (2006-2009)	Rs. 8,99,000/-
Design a Sustainable Community and Planning Strategy to South India. (Dr. S. Palanivelraja)	UGC	3 YEARS (2006-2009)	Rs. 4,75,000/-
Rainwater Harvesting in Veeranam catchment. (Dr. M. Rajendran)	MoWR	3 years (2006-2009)	Rs. 33,39,000/-
Biodegradation of Combined Effluent of Textile Dyeing Units and Tapioca Starch Industries by using Two phase Hybrid UASB Reactor. (Dr. V. Arutchelvan)	UGC	3 Years (2006-2010)	Rs. 11,07,100/-
A Long-Term Comparative Study of Ground Water Quality and Modeling in Tsunami affected areas of Nagapattinam District, Tamilnadu. (Dr. S. Poongothai)	UGC	2 Years (2007-2009)	Rs. 8,00,400/-

Site Specific Characterization and Validation of atmospheric Dispersion Model by Tracer Release Experiments. (Dr. M. Rajendran)	IGCAR-Kalpakkam	3 Years (2007-2010)	Rs. 29,14,000/-
Development of Evaluation of Multiplume Gaussian Diffusion Model Intended for Air Quality Regulatory Purposes. (Dr. S. Palanivelraja)	TNPCB	2 Years (2010-2012)	4,70,000/-
Integrated Farming – Rainwater harvesting – Recharge Groundwater – Preventing Seawater Intrusion. (Dr. V. Arutchelvan)	DST, Govt. of India.	2 years (2011-2013)	Rs. 16,75,000/-

**VII. Research Collaborations National /International / Consultancy / Patents / Copyright / Design etc.**

Sl. No	Name of Project	Principal Investigator/ Co Principal Investigator	Funding Agency	Period	Consultancy Fee	Status
1	Risk Analysis & Risk Management Plan Veerapandi CETP, Tiruppur	Dr. S. Mohan Dr. R. Saravanan	Veerapandi CETP, Tiruppur	2009-2010	3,00,000/-	Completed
2	Risk Analysis & Risk Management Plan Karaipudur CETP, Tiruppur	Dr. S. Mohan Dr.Rm.Meyyappan	Karaipudur CETP, Tiruppur	2009-2010	3,00,000/-	Completed
3	Risk Analysis & Risk Management Plan Mannarai CETP, Tiruppur	Dr. S. Mohan Dr.Rm.Meyyappan	Mannarai CETP, Tiruppur	2009-2010	3,00,000/-	Completed
4	Risk Analysis & Risk Management Plan Andipalayam CETP, Tiruppur	Dr. S. Mohan Dr. R. Saravanan	Andipalayam CETP, Tiruppur	2009-2010	3,00,000/-	Completed
5	Risk Analysis & Risk Management Plan Angeripalayam CETP, Tiruppur	Dr. V. Nehru kumar Dr. R. Saravanan	Angeripalayam CETP, Tiruppur	2009-2010	3,00,000/-	Completed
6	Risk Analysis for M/s. Pondicherry Nitrous Oxide Pvt. Ltd., Puducherry	Dr. R. Saravanan	M/s. Pondicherry Nitrous Oxide Pvt. Ltd., Puducherry	2009-2010	50,000/-	Completed
7	GPS. Maps info Consultancy for Veerapondi CETP, Tiruppur	Mr. T. Ramesh	Veerapondi CETP, Tiruppur	2009-2010	2,50,000/-	Completed
8	GPS. Maps info Consultancy for Mannarai CETP, Tiruppur	Mr. K. Balaji	Mannarai CETP, Tiruppur	2009-2010	1,50,000/-	Completed
9	GPS. Maps info Consultancy for Andipalayam CETP, Tiruppur	Mr. S. Syed Enayathali	Andipalayam CETP, Tiruppur	2009-2010	1,50,000/-	Completed
10	ETP – Augmentation Consultancy as Project management Consultants for M/s. Ponlait, Puducherry.	Dr. V. Nehrukumar	M/s. Ponlait, Puducherry.	2009-2010	2,50,000/-	On-Going
11	EIA/EMP for SIPCOT Industrial Park, Thervoykandigai, Chennai	Dr. V. Nehru kumar	SIPCOT Government of Tamilnadu Chennai	2009-2010	7,50,000/-	Completed
12	EIA / EMP for SIPCOT Industrial Park, Pillaipakkam, Chennai.	Dr. V. Nehru kumar	SIPCOT Government of Tamilnadu Chennai	2009-2010	4,50,000/-	Completed
13	AAQM for Three Project FLC Project locations	Dr. S. Palanivel raja	WAPCOS, New Delhi	2009-2010	2,00,000/-	Completed
<b>Net amount during 2009-10 :37,50,000/=</b>						
14	EIA / EMP for M/s. Marg. Port, Mugayur	Dr. V. Nehru kumar	Marg Swarnaboom i. Chennai	2010-2011	20,00,000/-	On-Going

15	AAQM for Cheyyur Power Project	Dr.S.Mohan	WAPCOS, New Delhi	2011-2012	4,00,000 /=	Completed
16	Additional Environmental Studies for EIA towards Fishing Harbor at Poombuhar	Dr.S.Palanivel raja Dr.S.Mohan	Department of Fisheries Government of Tamilnadu	2011-2012	2,00,000 /=	On-Going
17	INTER SECTORAL EIA for ICZMA for Tamilnadu Coast	Dr.V.Nehru Kumar	DHI India, Directorate of Environment , Government of Tamilnadu	2011-2012	29,00,000 0/=	On-Going
<b>Net amount during 2011-12 : 55,00,000/=</b>						
18	Augmentation Methodology for the Existing Common Effluent Treatment Plant & Technical Arbitration for Angeripalayam CETP, Tiruppur	Dr.V.Nehru Kumar Dr.G.B.JaiPrakash Narain( Empanelled Expert)	Angeripalayam CETP, Tiruppur	2012-13	10,00,000 0/=	On - Going
19	Vallam-Vaipar Industrial Park, Sriperumpudur Taluk, Kanjeeपुरam District	Dr.V.Nehru Kumar Dr.R.Saravanan	SIPCOT ,Govt of Tamilnadu	2012-13	6,00,000 /=	On-going
20	Vaipur-Mathur Industrial Park, Sriperumpudur Taluk, Kanjeeपुरam District	Dr.V.Nehru Kumar Dr.S.Palanivel raja	SIPCOT ,Govt of Tamilnadu	2012-13	6,00,000 /=	On-going
<b>Net amount during 2012-13 : 22,00,000/=</b>						
<b>Net Value = 1,14,50,000 ( Rupees One Hundred and Fourteen Lakhs and Fifty Thousands)</b>						

**VIII. M. Phil / Ph.D. awarded**

S. No.	Name of the Faculty / Supervisor	Name of the candidate	Full-Time/Part-Time	Title	Year of Ph.D. Awarded
1	Dr.V.Nehrukumar	B.Asha	Part-Time	Diphasic Digester for the treatment of Distillery wastewater	2007
2	Dr.V.Kanakasabai	V.Damodharan	Part-Time	Solid waste Management using In-Vessel Method	2009
3	Dr. A. Murugappan	N. Manikumari	Part-Time	Optimal Operation of a Tank Irrigation System	2010
4	Dr. S. Palanivelraja	K.I. Manirathinem	External	Indoor Air Quality Studies on the Solar Paneled Pyramidal Roof of Rural House	2010
5	Dr. V. Arutchelvan	M. Senthilkumar	External	Biominalisation of Textile Dyeing Effluent in Bi-Phasic UASB Reactor” Ph.D. awarded in April 2011.	2011
6	Dr. V. Nehrukumar	Selvakumar D	Full-Time	Performance and Kinetic Study on Modified RBC for Treating Biodegradable Industrial Waste Streams	2011
7	Dr. V. Arutchelvan	G. Gnanapragasam	Full-Time	Influence of Effluent Recycling on Biodegradation of Combined Textile Dyeing and Sago Effluent in two phase UASB Reactor.	2011
8	Dr. S. Palanivelraja	B. Kumaravel	Part-Time	Effect of air pollution on agriculture with special emphasis on crop yield in the vicinity of industrial complex.	2012
9	Dr. A. Murugappan	C.C. Monson	Part-time	Integrating twin technology of in-vessel and vermicomposting for solid waste management	2012

10	Dr. S. Poongothai	C. Puthiyasekar	External	Environmental Impact of Pollution on Ground Water Near Industrial and Sea shore Areas of Tirunelveli and Thoothikudi Region	2012
11	Dr. V. Nehrukumar	S. Selvan	External	Evaluation Studies on Integrated Environmental Management Systems for Textile Dyeing Industries	2012
12	Dr. V. Arutchelvan	P. Sivarajan	Part-Time	Biodegradation of Chlorophenols in a Biphasic UASB Reactor using Starch as Co-substrate	2012
13	Dr. V. Nehrukumar	C. Jodhi	Part-time	A Study on Variations in Biological Treatment Kinetics Under Different methods of Aeration in Industrial Effluent Treatment	2012

**IX. Publication:**

<b>Year</b>	<b>Author (s) / Title / Year / Journal Name /Vol</b>	<b>National</b>	<b>Internat ional</b>	<b>Indexed Journal</b>	<b>Citation Indication (if any)</b>	<b>Impact Factor</b>
2007	Pannirselvan, N, Murugappan, A and Arulmozhi, R, "Impact of Emissions of Co2 from Thermal Power Plants on Climate – A case Study" Quarterly International Journal of Ecology, Environment & Conservation, Volume 13, No. 2, 2007.		Internati onal	ISSN 0971-765X		
2007	Selvakumar., and Nehrukumar, V., "Effect of Organic Loading Rates for Treating Sugar and Dairy Industrial Waste Streams in Rotating Biological Contractors" 26(3): 389- 391 (2007).	National				
2007	Selvakumar., and Nehrukumar, V., "Effect of Rotational Speed OF Disc for Treating Sugar and Dairy Effluent Streams in Rotating Biological Contractors" Journal of Industrial Pollution Control 23 (2) 2007, pp 247-250.		Internati onal	ISSN 0970-2083		
2007	Jodhi, C., and Nehrukumar , V., "Evaluation Studies on aeration Methods for Treating Sugar Effluent in suspended – Growth Aerobic Reactor.- Nature Environment and Pollution Technology, Vol. 6, No. 3, pp 481 to 484	National		ISSN 0972-6268		
2007	Jodhi, C., and Nehrukumar , V., "Evaluation Studies on Aeration Methods for Treating Sugar Effluent in Attached – Growth and Aerobic reactor- Journal Of Industrial Pollution Control 23 (2) 2007, pp 227-230.		Internati onal	ISSN 0970-2083		
2007	Arutchelvan V. et al." Use of Biomass as an alternative fuel in S.I.Engine Emission and Comparative studies with conventional fuels". Ecology, Environment and Conservation 13(5), 1-6.		Internati onal	ISSN0971-765X		

2007	Arutchelvan V. et al. "Removal of hexavalent Chromium by biosorption". Ecology, Environment and Conservation 13(3), 611-614, 2007		International	ISSN0971-765X		
2007	Arutchelvan V. et al. "Removal of Hexavalent Chromium by using Biowaste material as Adsorbent". Ecology, Environment and Conservation 13(312-316).		International	ISSN0971-765X		
2007	Ravishankar,N., and Poongothai, S. "Spatial Analysis of Ground water Quality in the Tsunami Affected Costal Areas of Tamilnadu", National journal of Nature Environment and Pollution Technology Techno science Publications. Volume 6(4), pp 583-588	National		ISSN 0972-6268		
2008	Manikumari N., and Murugappan, A., "Fuzzy Logic Based Model for Optimization of Tank Irrigation System" Medwell Online Journal of Engineering and Applied Sciences, 3 (2), 2008, pp 199-202.		International	ISSN 1818-7803	1	
2008	Murugappan, A and Senthilkumar, G., "Application of Nanotechnology to Water Treatment – An Overview", of the Institution of Public Health Engineers, India, Volume 2008-2009 No. 1, pp 5-9.	National		ISSN 0970-3195		
2008	Selvan, S., and Nehrukumar, V., "Evaluation of Pretreatment Processes for zld Plants for Treating Composite Dyeing Effluent Streams", Industrial Pollution Control 24 (2) 2008 pp 165-168.	National		ISSN 0970-2083		
2008	Ravishankar, N., and Poongothai, S. "A study on Groundwater Quality in Tsunami affected areas of Sirkali Taluk, Nagapattinam District, Tamilnadu", India. International Journal of Science of Tsunami Hazards, Vol.27, No.1, 47-53.		International	ISSN 8755-6839		
2008	Ezhisaivallabi, K., and Poongothai, S. "Assessment of Water Resources of A Coastal Watershed Tamilnadu". National Journal of Applied Hydrology Publication of JAH volume No.XXI No.1&2. Manuscript No.701.	National		ISSN 0971-670X		



2009	Venkatesh, K.R ., Rajendran M., and Murugappan, A- “A Case Study on Physic-chemical Characteristics of Domestic Sewage” Nature Environment and Pollution Technology An International Quarterly Scientific Journal . Volume 8, No. 1, 2009, pp 141 – 145.		Internati onal	ISSN 0972-6268		
2009	Manikumari, N, Murugappan A., and Nagashree, B.S., “Application of GIS to Estimate Crop Water Requirement” Quarterly International Journal of Ecology, Environment & Conservation, Volume 15, No. 1, 2009, pp 121-126.		Internati onal	ISSN 0971-765X		
2009	Selvan, S., and Nehrukumar, V., “Strategies for Effluent Reduction at Source and on-Floor Management for Reuse, in Cabinet Dyeing Units for Yarn Dyeing” Asian Journal of Microbial Biotech. Env. Sc. Vol.: ii, No. (:2009, 227-229.):	National				
2009	Arutchelvan V. et al. “ Biomineralization of textile dyeing effluent in two phase hybrid UASB reactor using tapioca starch effluent as a co-substrate Journal of Environmental and Waste Management, 3(3/4),354-365.		Internati onal	ISSN 1478-9876	4	
2009	Arutchelvan V. et al. “Effect of enhancement techniques on the biological stabilization of municipal solid waste using In-vessel composting system”, Journal of Industrial Pollution. 25(2), 161-166.		Internati onal			
2009	Puthiya Sekar, K., Poongothai, S and Neelakandan, M.A “Impact of Industrial Pollution on the Physico-Chemical Characteristics of Sea Water in Thoothukudi Coastal Area”, Rasayan- An International Quarterly Research Journal of Chemical Sciences, Vol.2 No.4, pp912-919.		Internati onal	ISSN 0974-1496		0.292
2009	Palanivelraja, S., and Manirathinem K.I., “Studies on		Internati			

	Indoor Air Quality in a Rural Sustainable Home” Poll res. 28 (4): 609-614 (2009)		onal			
2009	Palanivelraja, S., and Manirathinem ., “Dispersion Modeling and Investigation on Indoor Air Quality in a Green House” Indian Journal of Air Pollution Control Vol. IX No. 2 September 2009, pp 73-83.	National		ISSN 0250-5231		
2010	Murugappan, A, Senthilkumar, G., and Sankaran, S., “Nanotechnology Environmental Health and Ethical Issues” Indian Journal of Environmental Protection, Volume 29, No. 9, pp 761-766.	National		ISSN 0253-7141		
2010	Murugappan, A., Gnanakumar, S., and Senthilkumar G., “Assessment of Shallow Groundwater Quality in Usuppur Village Panchayat in Chidambaram Taluk Cuddalore District, Tamilnadu state”, Nature Environment and Pollution Technology, An International Quarterly Scientific Journal, Vol. 9, No. 1, 2010, pp 167-172.		Internati onal	ISSN 0972-6268		
2010	Monson, C.C, and Murugappan, A., “Developing Optimal Combination of Bulking Agents in Composting of Vegetable Waste in an Air-Vessel” E-Journal of Chemistry, 2010.		Internati onal	ISSN 0973-4945		0.716
2010	Murugappan, A., and Krishnamurthy, J., “Domestic Water Conservation Role of Women” Journal of the Institution of Public Health Engineers, India, Volume 2009-2010, No. 3, pp 32-35.	National		ISSN 0970-3195		
2010	Monson, C.C., and Murugappan, A., “Combined Thermophillic Composting and Vermicomposting in the Bioconversion of Vegetable Market Waste” International Journal of Applied Engineering Research, May 2010.		Internati onal	ISSN 0973-4562		
2010	Murugappan, A., and Sivaprakasam Subbarayan., “Kidney Stones and Global Warming”, Everyman`s	National				

	Science, A Publication of the Indian Science Congress Association, Vol.XLV No.2(June`10-July`10), pp.102-105					
2010	Arutchelvan V. et al. “ Recycle in Upflow anaerobic sludge blanket reactor on treatment of real textile dye effluent”, World J.Microbiol.Biotechnol.26(6) 1093-1098. ”		International	ISSN 1093-1098	3	1.532
2010	Arutchelvan V. et al. “Startup characteristics of HUASB and UASB reactors for treating tapioca-based starch industrial waste stream: A comparison”. Poll Res.29(1): 99-104.		International	ISSN 20257-8050		
2010	Arutchelvan V. et al. “Startup regime of a two phase upflow anaerobic sludge blanket reactor”, J.Ind.Pollut.Control.26(2), 225-230.		International	ISSN 0970-2083		
2010	Arutchelvan V. et al. “Biokinetic analysis on treatment of textile dye wastewater using anaerobic batch reactor “. Biores. Technol.102(2) 627-632.		International	ISSN 0960-8524	5	4.932
2010	Palanivelraja, S. et. al. “Multiple point source complex shorter-period (MPCSP) average model: An alternative AAQ model for Indian Environment, PP 115-122, Vol.29(1)		International			
2010	Palanivelraja, S. et. al. “Dispersion pattern of sulphur dioxide in the neighbourhood of Thermal Power Stations at Neyveli. , PP 218-223, Vol.30(3)		International			
2010	Palanivelraja, S. et. al. “Effect of emission from thermal poer station on growth and yield of rice crop at selected rural sites in Cuddalore district of Tamilnadu, PP 13-18, Vol.9(1)		International			
2010	Palanivelraja, S. et. al. “Long term dispersion pattern of SO2 in the Neighbourhood of Thermal Power Stations at Neyveli, India. Vol.5.		International			
2010	Palanivelraja, S. et. al. “Multiple Point source		Internati			

	Complex model average concentrations for the Uder Specied Sampling Period, PP.62-68.		onal			
2011	Sivaprakasam Subburayan, Murugappan, A., and Mohan, S., "Modified Hargreaves Equation for Estimation of ETo in a Hot and Humid Location in Tamilnadu State, India", International Journal of Engineering Science & Technology, Vol.3, No.1, January 2011		Internati onal	ISSN 2278-9510		
2011	Murugappan, A., Subbarayan Sivaprakasam and Mohan, S., "Prediction of Solar Radiation with Air Temperature Data in a Coastal Location in Tamilnadu", MAUSAM, Vol.62, No.1, January 2011, pp. 85-90.	National		ISSN 0252-9416		
2011	Murugappan, A., Manoharan, A., and Senthilkumar, G., "Effects of Lignite Mine Drainage on Irrigated Command Areas – A Case Study", Journal of Agricultural Engineering Research, March 2011		Internati onal	ISSN 0021-8634		
2011	Senthilkumar, G., Senthilkumar, PL., and Murugappan, A., "Investigation on Application of Catalytic Substances for Augmenting Worm Growth Rate in Vermicomposting", Journal of the Institution of Public Health Engineers, India, Volume 2011-2012, No.1, April 2011, pp. 15-19.	National		ISSN 1735-7586		
2011	Murugappan. A., Sivaprakasam Subburayan, Mohan. S., "Performance Evaluation of Calibrated Hargreaves Method for Estimation of Ref- ET in a Hot and Humid Coastal Location in India", International Journal of Engineering Science & Technology, Vol.3, No.6, June 2011, pp. 4728-4743.		Internati onal	ISSN 2278-9510		
2011	Sivaprakasam Subburayan and Murugappan, A., "Climate Change: Long Term Variability in Rainfall		Internati onal	ISSN 2229-5216		

	in and around Cuddalore District, Tamilnadu State, India”, International Journal of Advances in Science & Technology, Vol.3, No. 2, August 2011.					
2011	Arutchelvan V. et al. “Treatment of textile dyeing wastewater using two-phase pilot plant UASB reactor with sago wastewater as co-substrate“. Chemical Engineering Journal 166(1), 10-14.		International	ISSN 1385-8947	2	3.461
2011	Arutchelvan V. et al. “ Influence of hydraulic retention time in two-phase Upflow anaerobic sludge blanket reactor treating textile dye effluent using sago effluent as the co-substrate”, Environmental Science and Pollution Research.		International	ISSN 0944-1344	1	
2011	Arutchelvan V. et al. “ Effect of temperature on treatment of combined real textile dyeing and sago effluent using pilot scale tow phase Upflow anaerobic sludge blanket reactor “. Journal of Biochemistry and Biotechnology 1(2).		International	ISSN 15533468	1	0.900
2011	Arutchelvan V. et al. “Removal of copper and Chromium heavy metals from industrial wastewater by biosorption”, Poll Res.30(4), 483-488.		International	ISSN 0257-8050		
2011	Arutchelvan V. et al. “ Biodegradation of 2 Chlorophenol in an anaerobic batch reactor using starch as co-substrate” , Poll Res.30(4), 593-597.		International	ISSN 0257-8050		
2011	Karthikeyan, K and Poongothai, S. “Groundwater Hydrogeochemisitry of Bhuvanagri Block, Chidambaram Taluk, Cuddalore District, Tamilnadu, India”. Enviro Media, International Journal Ecology, Environmental and Conservation, Karad		International	ISSN 0971-765X		
2011	Nagarajan, N., and Poongothai, S. “Identification of Groundwater Potential in Contact zones by using GIS and Electrical Resistivity Analysis”. International Journal of (ESTIJ), IRACST – Engineering Science and Technology Vol. 1, No.1, ISSN: 2250-3498		International	ISSN 2250-3498		

2011	Nagarajan, N., and Poongothai, S. "Spatial Mapping of Runoff from a Watershed using SCS-CN Method, Remote Sensing and GIS". Journal of Hydrologic Engineering , ASCE, Special Issue doi:10.1061/(ASCE) HE.1943-5584.0000520		International	ISSN 1084-0699		
2011	Nagarajan, N., and Poongothai, S. "Trend in Land use/Land Cover change detection by RS and GIS application", International Journal of Engineering and Technology , Vol.3 (4), 2011, pp263-269 (ISSN:0975-4024.		International	(ISSN:0975-4024.		
2011	Nagarajan, N., and Poongothai, S. "Identification of Land use and Land cover changes using Remote Sensing and GIS",IACSIT International Journal of Engineering and Technology , Vol.3, No.5,October 2011, pp570-576 (ISSN:1793-8244) Online version: 1793-8236 (Print version)		International	(ISSN:1793-8244)		
2011	Nagarajan, N., Ramesh, S and Poongothai, S. "Land use in Suburbia: Perungalathur Village of Chennai Metropolitan Area", International Journal of Science & Engineering Research Volume 2 Issue 8, (ISSN 2229-5518)		International	(ISSN 2229-5518)		
2011	Nagarajan, N., and Poongothai, S. "Effect of Land Use/Land Cover Change Detection of Ungauged Watershed", International Journal of WASJ		International	ISSN 1818-4952		
2012	Manoharan, A., and Murugappan, A., "Estimation of Runoff in an Ungauged Rural Watershed, Tamilnadu State, India", International Journal of Engineering Science & Technology, Vol. 4, No. 2, February 2012, pp. 449-456.		International	ISSN 1793-8236		
2012	Sankaran.S et.al. , "Meteorological potential for air pollutant dispersion in urban and rural areas along the east coast of Tamilnadu" in International Journal of Engineering Science & Technology (IJEST)., ISSN : 0975-5462 Vol.4 No.6June 2012., Pg 2552-2559		International	ISSN : 0975-5462		

2012	Sankaran.S et.al. , “Methyl Mercaptan Monitoring in the Neighborhood of SIPCOT Industrial Estate Cuddalore, Tamil Nadu” in Indian Journal of Environmental Protection (IJEP). ISSN: 0253-7141. Vol.32.No.4.April 2012. Pg 313-316	National		. ISSN: 0253-7141		
2012	Karthikeyan, K and Poongothai, S, “Identification of Groundwater potential and Recharge zones using Electrical Resistivity Techniques in lower Vellar watershed, Cuddalore District, Tamilnadu”. International Journal Earth science and Engineering, ISSN no 0974-5904		International	ISSN 0974-5904		
2012	Karthikeyan, K and Poongothai, S, “Characterization of Ground water quality and its suitability study in part of lower vellar watershed Cuddalore District, Tamilnadu ”. International Journal Nature Environment & pollution Technology, ISSN No 0972-6268 Vol. No 11.		International	ISSN 0972-6268		
2012	Balaji K and Poongothai S “Decolourisation of Dyeing Effluent by the Fungal Biomass in a Fluidized Bed Reactor” International Journal of Pharmaceutical & Biological Archives, ISSN 0976-3333,		International	ISSN 0976-3333		
2012	Balaji K and Poongothai S “Evaluation of Fluidized Bed Reactor in treating Dyeing Effluent” International Journal of Engineering Science and Technology (IJEST) ISSN 0975-5462, Vo. 4,		International	ISSN 0975-5462		

**X. Seminar / Symposia Organized / Sessions Chaired :**

Year	Name of Seminar / Conference / Workshop	Source of Funding
2007	National Workshop on "Nanotechnology: Environmental Implications and Solutions" on 9-10 March 2007	UGC
2008	National seminar on "Spatial Modeling and Soft Computing in Water Resources Management" on 14-15, March 2008	UGC
2010	National Conference on "Sustainable Community construction Concepts for Evolving the SlumS" on 20-21, February 2010.	UGC
2012	National Conference on "Global perspectives on water resources and environment" on 22-23, March 2012.	UGC



**X1. Seminar / Symposia attended:**

Year	Seminars / Symposia Attended
2007-2008	8
2008-2009	3
2009-2010	10
2010-2011	4
2011-2012	9

### **XIII. MoU National / International:**

An MoU was signed with Fukui University, Japan for student exchange Programme.

A student from Japan underwent a Post Graduate Program on “Temple Architecture” during the year 2006-2008.

#### **XIV. Academic Distinction / Honours / Awards :**

##### **Best Paper Award**

The research article entitled “Study on Variability in Certain Meteorological Parameters in Cuddalore District, Tamilnadu State, India” authored by Sivaprakasam, S and Murugappan, A. presented in the International Conference on Recent Advances in Space Technology Services & Climate Change (RSTS&CC-2010), organized by Sathyabama University, Chennai, in association with Indian Space Research Organization (ISRO), Bangalore, IEEE and Indian Society of Remote Sensing (ISRS), 13<sup>th</sup> to 15<sup>th</sup> November 2010, has won the Best Paper Award.

## **XV. Distinguished Alumnus:**

Prof.RM.Sethunarayanan

- Former Vice Chancellor, (1945 Batch) Annamalai University

Mr.Subramanian - Sr.Vice President, (1958 Batch) Reliance Industries Limited

Mr.S.D.Somasundaram - Minister for PWD (Former), (1961 Batch), Tamil Nadu State Government

Prof.R.Janardhanam - Professor of Civil Engineering, (1967 Batch), University of North Carolina,U.S

Dr.K.R.Ranganathan - Member Secretary (Retd), Central Pollution Control Board

Dr.R.C.Janagarajan - Registrar (Former), (1962 Batch), I I T MADRAS, Professor Emeritus, Anna University

Mr.S.Sivaraman - Chief Engineer General (Retd.), (1965 Batch), PWD, Tamil Nadu State

Mr.S.Kalaichelvan - Chief Engineer (Retd.), (1965 Batch), PWD, Tamil Nadu State

Mr.A.Kanagasabapathy - Chief Engineer (WRO) (Retd.), (1965 Batch), Director, Institute of Water studies

Dr.Samidurai - Registrar (Former), (1965 Batch), I I T MADRAS

Mr.S.Krishnamurthy - M/s Kannan Constructions, (1965 Batch), Pondicherry

Mr.N.Venkatachalam - Former Director, (1965 Batch), Town Planning Authority Tamil Nadu State Government

Mr.R.Paranthaman - Chief Engineer (Retd), (1966 Batch), PWD,Tamil Nadu State

Mr.V.Kannappan - VKN, Tiruchirapalli, (1968 Batch), Leading Contractors to Reliance & BHEL

Mr.RM.Kanappan - Chief Engineer, (1969 Batch), Highways (NABARD), Tamil Nadu State

Mr.K.Sundaramurthy - Chief Engineer, (1969 Batch), Highways (R R), Tamil Nadu State

Mr.M.Vekatesan - Chief Engineer, (1969 Batch), Highways (N H), Tamil Nadu State

Mr.R.Ramachandran - Additional Chief Environmental, (1976 Batch), Engineer, Tamil Nadu State Pollution Control Board

Mr.S.Balaji - Joint Chief Environmental Engineer, (1977 Batch),  
Tamil Nadu State Pollution Control Board

Mr.G.Muthuvenkatramani - Deputy Chief Engineer, (1977 Batch) M.N Dastur & Company  
Limited

Mr.R.Gurunathan - Deputy General Manager (Civil), (1977 Batch)  
ECC – Construction Division, Larsen & Toubro Limited

Mr.N.S.Ramalingam - Deputy General Manager (Civil), (1978 Batch), Neyveli Lignite  
Corporation Limited

Mr.Chakravarthi - Deputy General Manager (Civil), (1979 Batch), Neyveli Lignite  
Corporation Limited

Mr.A.Balaravi - Manager, (1982 Batch), IOC, Chennai

Mr.Tanmay Basu - Executive Engineer (Civil), ONGC

Mr.M.S.Gandhi - Executive Engineer (Civil) ONGC

Mr.Allaudin - Executive Engineer (Civil), ONGC

Er. A.C. Kamaraj – Chairman, NAWAD Council

Er. E. Harikrishnan – Indian Administrative Service