

GURU GHASIDAS VISHWAVIDYALAYA, INSTITUTE OF TECHNOLOGY; DEPARTMENT  
OF CIVIL ENGINEERING

**SCHEME of B.TECH.- III - SEMESTER - CIVIL ENGINEERING**

WEF : ODD SEMESTER OF SESSION – 2012-2013

SN	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					CREDITS
			L	T	P	SESSIONAL - TA			ESE	SUB-TOTAL	
						IA	MSE	TOTAL			
<b>THEORY</b>											
1	21CE01T	ENGINEERING MATHEMATICS - III	3	1	-	20	20	40	60	100	4
2	21CE02T	SURVEYING -I	3	1	-	20	20	40	60	100	4
3	21CE03T	STRENGTH OF MATERIALS	3	1	-	20	20	40	60	100	4
4	21CE04T	CIVIL ENGG. MATERIALS & CONCRETE TECHNOLOGY	3	1	-	20	20	40	60	100	4
5	21CE05T	ENGINEERING GEOLOGY	3	1	-	20	20	40	60	100	4
<b>PRACTICAL</b>											
6	21CE06P	SURVEYING –I FIELD WORK	-	-	3	30	-	30	20	50	2
7	21CE07P	MATERIAL TESTING LAB.	-	-	3	30	-	30	20	50	2
8	21CE08P	CIVIL ENGINEERING DRAWING	-	-	3	30	-	30	20	50	2
<b>GRAND TOTAL</b>			<b>15</b>	<b>5</b>	<b>9</b>	<b>190</b>	<b>100</b>	<b>290</b>	<b>360</b>	<b>650</b>	<b>26</b>

**SCHEME of B.TECH. - IV - SEMESTER - CIVIL ENGINEERING**

WEF : EVEN SEMESTER OF SESSION – 2012-2013

S N	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					CREDIT S
			L	T	P	SESSIONAL - TA			ESE	SUB-TOTAL	
						IA	MSE	TOTAL			
<b>THEORY</b>											
1	22CE01T	STRUCTURAL ANALYSIS - I	3	1	-	20	20	40	60	100	4
2	22CE02T	TRANSPORTATION ENGINEERING - I	3	1	-	20	20	40	60	100	4
3	22CE03T	SURVEYING - II	3	1	-	20	20	40	60	100	4
4	22CE04T	FLUID MECHANICS - I	3	1	-	20	20	40	60	100	4
5	22CE05T	BUILDING CONSTRUCTION	3	1	-	20	20	40	60	100	4
<b>PRACTICAL</b>											
6	22CE06P	SURVEYING – II - FIELD WORK	-	-	3	30	-	30	20	50	2
7	22CE07P	FLUID MECHANICS –I LAB.	-	-	3	30	-	30	20	50	2
8	22CE08P	TRANSPORTATION ENGINEERING – LAB	-	-	3	30	-	30	20	50	2
<b>GRAND TOTAL</b>			<b>15</b>	<b>5</b>	<b>9</b>	<b>190</b>	<b>100</b>	<b>290</b>	<b>360</b>	<b>650</b>	<b>26</b>

## SCHEME of B.TECH. – V - SEMESTER - CIVIL ENGINEERING

WEF : ODD SEMESTER OF SESSION – 2013-2014

SN	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					CREDITS
						SESSIONAL TA			ESE	SUB-TOTAL	
			L	T	P	IA	MSE	TOTAL			
<b>THEORY</b>											
1	31CE01T	STRUCTURAL ANALYSIS - II	3	1	-	20	20	40	60	100	4
2	31CE02T	DESIGN OF CONCRETE STRUCTURES – I	3	1	-	20	20	40	60	100	4
3	31CE03T	FLUID MECHANICS - II	3	1	-	20	20	40	60	100	4
4	31CE04T	GEO- TECHNICAL ENGINEERING - I	3	1	-	20	20	40	60	100	4
5	31CE05T	TRANSPORTATION ENGINEERING - II	3	1	-	20	20	40	60	100	4
<b>PRACTICAL</b>											
6	31CE06P	FLUID MECHANICS - II	-	-	3	30	-	30	20	50	2
7	31CE07P	GEO- TECHNICAL ENGINEERING – I - LAB	-	-	3	30	-	30	20	50	2
8	31CE08P	COMPUTER APPLICATIONS IN CIVIL ENGG. LAB	-	-	3	30	-	30	20	50	2
<b>GRAND TOTAL</b>			<b>15</b>	<b>5</b>	<b>9</b>	<b>190</b>	<b>100</b>	<b>290</b>	<b>360</b>	<b>650</b>	<b>26</b>

## SCHEME of B.TECH. – VI - SEMESTER - CIVIL ENGINEERING

WEF : EVEN SEMESTER OF SESSION – 2013-2014

SN	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					CREDITS
						SESSIONAL TA			ESE	SUB-TOTAL	
			L	T	P	IA	MSE	TOTAL			
<b>THEORY</b>											
1	32CE01T	DESIGN OF STEEL STRUCTURES	3	1	-	20	20	40	60	100	4
2	32CE02T	GEO- TECHNICAL ENGINEERING- II	3	1	-	20	20	40	60	100	4
3	32CE03T	ENVIRONMENTAL ENGINEERING - I	3	1	-	20	20	40	60	100	4
4	32CE04T	WATER RESOURCES ENGINEERING - I	3	1	-	20	20	40	60	100	4
5	32CE05T	ESTIMATING & COSTING	3	1	-	20	20	40	60	100	4
<b>PRACTICAL</b>											
6	32CE06P	STEEL STRUCTURES DETAILING	-	-	3	30	-	30	20	50	2

7	32CE07P	ENVIRONMENTAL ENGINEERING – I - LAB.	-	-	3	30	-	30	20	50	2
8	32CE08P	GEO- TECHNICAL ENGINEERING –II - LAB	-	-	3	30	-	30	20	50	2
<b>GRAND TOTAL</b>			<b>15</b>	<b>5</b>	<b>9</b>	<b>190</b>	<b>100</b>	<b>290</b>	<b>360</b>	<b>650</b>	<b>26</b>

## SCHEME of B.TECH. – VII - SEMESTER - CIVIL ENGINEERING

WEF : ODD SEMESTER OF SESSION – 2013-2014

SN	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				CREDITS	
			L	T	P	SESSIONAL TA			ESE		SUB-TOTAL
						IA	MSE	TOTAL			
<b>THEORY</b>											
1	CE41T01	STRUCTURAL ENGG. DESIGN - III	3	1	-	20	20	40	60	100	4
2	CE41T02	ENVIRONMENTAL ENGINEERING - II	3	1	-	20	20	40	60	100	4
3	CE41T03	WATER RESOURCES ENGINEERING - II	3	1	-	20	20	40	60	100	4
4	CE41T04 to CE41T13	ELECTIVE - I	3	1	-	20	20	40	60	100	4
5	CE41T14 to CE41T123	ELECTIVE - II	3	1	-	20	20	40	60	100	4
<b>PRACTICAL</b>											
6	CE41P24	ENVIRONMENTAL ENGG.-II - LAB	-	-	3	30	-	30	20	50	2
7	CE41P25	MINOR PROJECT	-	-	3	30	-	30	20	50	2
8	CE41P26	SEMINAR	-	-	3	30	-	30	20	50	2
<b>GRAND TOTAL</b>			<b>15</b>	<b>5</b>	<b>9</b>	<b>190</b>	<b>100</b>	<b>290</b>	<b>360</b>	<b>650</b>	<b>26</b>

L: LECTURE; T: TUTORIAL; P: PRACTICAL; IA : INTERNAL ASSESSMENT; MSE : MID SEMESTER EXAM; ESE : END SEMESTER EXAM

LIST OF ELECTIVE – I & II					
SN	COURSE CODE	SUBJECT	SN	COURSE CODE	SUBJECT
1	CE41T04	DESIGN OF PRESTRESSED CONCRETE	11	CE41T14	ADVANCED CONCRETE TECHNOLOGY
2	CE41T05	THEORY OF PLATE & SHELLS	12	CE41T15	ENGINEERING ECONOMICS
3	CE41T06	THEORY OF ELASTICITY & PLASTICITY	13	CE41T16	QUALITY CONTROL, ASSURANCE & SAFETY IN CONSTRUCTION

4	CE41T07	REHABILITATION OF STRUCTURES	14	CE41T17	MANAGEMENT INFORMATION SYSTEM
5	CE41T08	ADVANCE STRUCTURAL ANALYSIS	15	CE41T18	VALUE ENGINEERING
6	CE41T09	STRUCTURAL DYNAMICS	16	CE41T19	ENTERPRISE RESOURCE PLANNING
7	CE41T10	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	17	CE41T20	FINANCE MANAGEMENT
8	CE41T11	FRACTURE OF CONCRETE STRUCTURES	18	CE41T21	SAFETY IN CONSTRUCTION
9	CE41T12	ADVANCED STEEL DESIGN	19	CE41T22	CONSTRUCTION MATERIALS & MATERIALS MANAGEMENT
10	CE41T13	ADVANCED CONCRETE DESIGN			

## SCHEME OF B.TECH.- VIII - SEMESTER - CIVIL ENGINEERING

WEF : EVEN SEMESTER OF SESSION – 2013-2014

SN	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					CREDITS
			L	T	P	SESSIONAL - TA			ESE	SUB-TOTAL	
						IA	MSE	TOTAL			
<b>THEORY</b>											
1	CE42T01	STRUCTURAL ENGG. DESIGN -IV	3	1	-	20	20	40	60	100	4
2	CE42T02	CONSTRUCTION PLANNING & MANAGEMENT	3	1	-	20	20	40	60	100	4
3	CE42T03 to CE42T12	ELECTIVE - III	3	1	-	20	20	40	60	100	4
4	CE42T13 to CE42T22	ELECTIVE - IV	3	1	-	20	20	40	60	100	4
<b>PRACTICAL</b>											
5	CE42P23	STRUCTURAL ENGG. DESIGN	-	-	3	30	-	30	20	50	2
6	CE42P24	MAJOR PROJECT	-	-	9	90	-	90	60	150	6
7	CE42P25	PROFESSIONAL ETHICS	-	-	3	50	-	50	-	50	2
<b>GRAND TOTAL</b>			<b>12</b>	<b>4</b>	<b>15</b>	<b>250</b>	<b>80</b>	<b>330</b>	<b>320</b>	<b>650</b>	<b>26</b>

### LIST OF ELECTIVE – III & IV

SN	COURSE CODE	SUBJECT	SN	COURSE CODE	SUBJECT
1	CE42T03	AIR AND WATER QUALITY MODELLING	10	CE42T12	RAIN WATER HARVESTING

2	CE42T04	INDUSTRIAL WASTEWATER MANAGEMENT	11	CE42T13	<b>ADVANCE TRANSPORTATION ENGG.</b>
3	CE42T05	AIR POLLUTION CONTROL ENGINEERING	12	CE42T14	GROUND IMPROVEMENT TECHNIQUES
4	CE42T06	ENVIRONMENTAL IMPACT ASSESSMENT	13	CE42T15	DYNAMICS OF SOIL & FOUNDATION
5	CE42T07	SOLID AND HAZARDOUS WASTE MANAGEMENT	14	CE42T16	GEO-INFORMATICS & GIS APPLICATIONS
6	CE42T08	ENVIRONMENTAL GEO-TECHNOLOGY	15	CE42T17	ROCK MECHANICS
7	CE42T09	WATER RESOURCES PLANING & MANAGEMENT	16	CE42T18	PLANING & DESIGN OF BUILDING SERVICES
8	CE42T10	GROUND WATER HYDROLOGY	17	CE42T19	DISASTER MITIGATION & MANAGEMENT
9	CE42T11	ADVANCE FLUID MECHANICS			

## **21CE01T: ENGINEERING MATHEMATICS-III**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**UNIT-I Functions of a complex variable:** Complex variable, function of complex variable, limit, continuity, and differentiability, of a function of a complex variable. Analytic functions, Cauchy- Riemann equations, Orthogonal curves, harmonic functions, conformal mapping, bilinear transformation (Möbius transformation) Cauchy integral theorem, Cauchy integral formula, Cauchy's inequality Taylor theorem, Laurent's theorem.

**UNIT-II Fourier series and Fourier transform :** Periodic function, Fourier series, Dirichlet's conditions for a Fourier series. Advantages of Fourier series and determination of Fourier coefficients, Fourier series of function of periods 2, change of interval, Even Odd functions, Half range sine and cosine series, practical harmonic analysis, Fourier transformation, Fourier sine and cosine transform , properties of Fourier transform.

**UNIT-III Laplace transformation:** Laplace transformation, properties of Laplace transformation, first shift theorem, Laplace transform of the derivative of  $f(t)$ , multiplication and division by  $t$ . Unit step function: Laplace transformation of unit function, second shifting theorem, Laplace transform of function and periodic function. Inverse Laplace transformation Multiplication by  $s$ , division by  $s$ , first shifting property, second shifting property, inverse Laplace transform of derivatives , solution of differential equations by Laplace transform

**UNIT-IV Correlation & Regression :** Scatter diagram , Linear Correlation , Measures of Correlation . Karl Pearson's Coefficient of correlation , Limits for correlation coefficients, Coefficient of correlation for bivariate frequency distribution , Rank correlation , Linear Regression, Equations to the line of Regression. Regression coefficient . Angle between two lines of Regression .

**UNIT –V Theoretical Distributions:** Discrete and Continuous probability distribution's .Mathematical expectation, Mean and Variance, Moments, Moments generating function, probability distribution ,Binomial,Poisson and Normal distribution ,Test of significance sassed on chi-square , T,F,and Z distribution degree of freedom , conditions for applying X2 (chi-square) test , student's test.

**Reference books:**

KreyszigE “ Advanced Engineering mathematics”  
 Prasad C “ Advanced Engineering mathematics”  
 Pati T “ Functions of complex variables”  
 Dass H.K. “ Advanced Engineering mathematics”  
 Ray M. “ Mathematics statistics”  
 Higher Engg. Mathematics by Dr. B.S. Grewal– Khanna Publishers.  
 Advanced Engg. Mathematics by Erwin Kreyszig – John Wiley & Sons.  
 Advanced Engg.Mathematics by R.K. Jain and S.R.K. Iyengar – Narosa Publishing House.  
 Applied Mathematics by P.N.Wartikar & J.N. Wartikar. Vol- II– Pune Vidyarthi Griha Prakashan,Pune.  
 Applied Mathematics for Engineers & Physicists by Louis A. Pipes- TMH.

**21CE02T: SURVEYING -I**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**UNIT-I: INTRODUCTION AND CHAIN SURVEYING**

Definition - Principles - Classification - Fields and office work - Scales - Conventional signs – Survey instruments, their care and adjustment - Ranging and chaining - Reciprocal ranging - Setting perpendiculars - well-conditioned triangles.

**COMPASS SURVEYING**

Prismatic compass - Surveyor's compass - Bearing - Systems and conversions - Local attraction – Magnetic declination - Dip

**UNIT-II**

Different methods of determining elevations: Spirit, Trigometric and Barometric methods  
 Spirit leveling-Definitions of terms, Principle, Temporary and permanent adjustment of levels.  
 Sensitivity of bubble tube, Auto & Dumpy levels, Levelling staff, Methods of spirit leveling  
 Booking and reduction of field notes.  
 Types of leveling:- Reciprocal, Profile, Differential, Precise leveling, Plotting of profiles  
 Correction:- Curvature and refraction.

**CONTOURING**

Direct and Indirect methods of contouring. Interpolation of contours, Drawing section from contour map, Application and Modern methods of depicting relief on a Map.

**UNIT - III : THEODOLITE AND TRAVERSING**

Venire theodolites, Temporary and permanent adjustments, Requirements of nonadjustable parts, Measurement of horizontal angle by repetition and reiteration method, Measurement of vertical angles.

**AREA AND VOLUMES**

Computation of area and volume by different mathematical methods.

#### **UNIT - IV : PLANE TABLE SURVEYING**

Principles, Advantages and disadvantages, Plane table equipment, Use of Telescopic Alidade, Different methods of Plane Table Surveying, Resection-Two and Three point problems. Fields work in Plane Table Surveying.

#### **UNIT-V : CURVES**

Classification of curves; Elements of Simple, Compound, Reverse and Transition curves, Method of setting out Simple and Compound curves. Special field problems.

#### **Name of Text Books:**

Surveying (Vol. I & II) – Punmia, B.C. (Laxmi Publications, New Delhi, 1996)  
Surveying (Vol. I & II) – Kanetkar (Pune Vidyarthi Griha Prakashan, Pune)

#### **Name of Reference Books:**

Surveying (Vol. II & III) – Agor, R (Khanna publications, Delhi, 1995)  
Surveying (Vol. II & III) – Arora, K.R. (Standard Book House, Delhi, 1993)  
Fundamentals of Surveying – S.K. Roy (Prentice Hall of India)  
Surveying (Vol. I & II) – S.K. Duggal (Tata McGraw Hill)

### **21CE03T : STRENGTH OF MATERIALS**

			SESSIONAL - TA			ESE
	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

#### **Unit 1- Simple Stresses -Strain and compound stresses**

Types of stresses and strains, Mechanicals properties, Hooke's law, stress– strain curve for mild & Cast iron, hardness, impact strength, Poisson's ratio, Relation between the elastic moduli & Poisson's ratio, Bars subjected to varying loads, Temperature stresses in composite bars, Elongation of bars of constant and varying sections.

Stress at a point. Components of stress in rectangular coordinates, stresses on an inclined plane, Principal stresses & principle plane, Mohr's circle of stresses.

#### **Unit 2- Shear Force - Bending Moment and Bending Stress**

Shear Force & Bending Moment diagrams in statically determinate beams loaded with different load combination, Relationship between Load intensity- Shear Force - Bending Moment, Thrust diagram, Point of contraflexure, loading diagram & Bending moment diagram from shear force diagram, beam with internal hinge.

#### **Unit 3 Shear Stresses in Beams and Slope-Deflections of Beams**

Derivation of Shear Stress formula, assumptions, Shear stresses in symmetrical elastic beam with different sections.

Derivation of differential equation for deflection, Slope & Deflection of Beams by Double integration method, Macaulay's method & Moment area method. Propped cantilever.

#### **Unit 4 Torsion and Columns**

Equation of Pure Torsion, Assumptions, Power transmitted, Stiffness of Shafts, Comparison of Solid & Hollow shaft, Strain energy in Torsion. Stable and unstable equilibrium, Short columns, Euler's formula for long columns, Equivalent length, Limitation of Euler's formula, Rankine's formula.

#### **Unit 5 Thin -Thick Cyl;inders-Spheres and Rivet-welded Connection**

Stresses in Thin Cylinders, Changes in Dimensions of Cylinder, Rivetted Cylinders, Thin Spherical Shells. Thick Cylinders, Lamé's equation. Riveted Joints, Method of riveting, Types of joints, assumptions made in analysis of riveted joints, pitch of Rivets, Failure of a Riveted joint, Strength of a riveted joint, Efficiency of a Joint, Design of Riveted joints for axial load. Welded connection, Types of joints, strength of joints, size of weld, comparison of welded & Riveted joints.

**Text Books:** Strength of Materials – R.K. Rajput (S. Chand & Co.)

**Name of Reference Books:** Mechanics of Structures (Vol. – I) – Junarkar (Charotar Publications)  
Strength of Materials – Timoshenko, S. & Gere (CBS Publishers)  
Introductions to Solid Mechanics –Shames & Pitarresi (Prentice Hall of India)  
Engineering Mechanics of Solid – Popov (Pearson Publication)  
Strength of Materials–S. Ramamurtham (Dhanpat Rai Publications)  
Strength of Materials (Part-I) – Timoshenko (CBS Publishers)

## **21CE04T: CIVIL ENGG. MATERIALS & CONCRETE TECHNOLOGY**

			SESSIONAL - TA			ESE
	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

#### **Unit I:**

**Manufacturing, properties, classification of building stones, bricks, tiles, timber,** seasoning and preservation of timber

#### **Unit 2**

#### **Miscellaneous Engineering Materials:**

Varieties of ceramics & glass: their properties & uses; Properties & uses of Plastics, Rubber and PVC. Composition, characteristics and use of paints, varnishes and distempers; Composite materials, types and uses; Adhesives & Asbestos, types, properties & uses; Thermal, Electrical & Sound Insulators: qualities & types.

#### **UNIT III**

Manufacturing, properties, classification of cement, aggregate and structural steel

#### **UNIT-IV**



**Concrete:** Properties of fresh and hardened concrete, long term and durability properties of concrete, Concrete mix design and its applications, admixtures in concrete, Non-destructive testing and evaluation,

#### UNIT-V

**Special concretes:** Fibre reinforce concrete, no fines concrete, polymer concrete, light weight concrete, high strength and high performance concrete, ready mixed concrete, green concrete, shotcrete concrete, smart concrete, recycled aggregate concrete

**Name of Text Books:** Building Materials – S.K. Duggal (New Age Publication)  
Building Materials – S. C. Rangwala (Charotar Publication)

**Reference Books:** Concrete Technology – A.M. Neville & J.J. Brooks (Pearson Education)  
Concrete Technology – M.S. Shetty (S. Chand & Co.)  
Engineering Materials – Surendra Singh (Laxmi Publication)  
Construction Engineering and Management – S. Seetharaman (UmeshPublication)  
Building Materials – Gurucharan Singh (Standard Publishers, Delhi)

## 21CE05T : ENGINEERING GEOLOGY

			SESSIONAL - TA			ESE
	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit 1:**Engineering Geology: Ground water, zones of ground water, water table and perched water table, water bearing properties of rocks, occurrence of ground water, springs, selection of a site for well sinking and ground water investigations.

Minerals : Minerals, their physical properties, optical properties and chemical properties. The detailed study of certain rock forming minerals with respect to the physical properties.

**Unit 2** Structural geology: Strike and dip, out crops, volcanoes, overlaps, inliers and outliers, types classification of folds, faults, joints, unconformities.

Rocks and Rock deformation :Their origin, structure, texture, classification of rocks in brief and their suitability as Engineering materials, dip and strike of bed, Folds, Faults, joints, unconformity and their classification, causes and relation to engineering behaviour of rock masses.

**Unit 3** Earthquake: Classification, causes and effects of earthquakes and land slides, seismic curve, seismographs, seismograms, accelograms, seismic problems of India, seismic zones of India, remedial measures to prevent damage for engineering structures, case histories.

Landslides and Land subsidence : Landslides, its causes, classification and preventive measures, land subsidence, its causes and preventive measures

**Unit 4**Geological investigation: Interpretation of geological maps, use of aerial maps in geological surveying, geophysical methods as applied to civil engineering for subsurface analysis (Electrical and Seismic methods).

Engineering Geological Sites Selection :Engineering Geological considerations for site selection of Dams and Reservoirs, Tunnels, Bridges and Highways, Geological Maps, concept of geological maps, important terminology used for map and making a section from the map.

**Unit 5:** Geology of dams and reservoirs: Types of dams, requirements of dam site, preliminary and detailed geological investigations for a dam site, important international and Indian examples of failures

of dams and their causes, factors affecting the seepage and leakage of the reservoirs and the remedial measures, silting of reservoirs.

Rock mechanics and tunneling: Purposes of tunneling and geological problems connected with tunneling, geological considerations in road alignment, roads in complicated regions, problems after road construction, geology of bridge sites.

**Name of Text Books:** A Textbook of Geology – Mukherjee P.K. (World Press Publishers)  
 Engineering Geology – D.S. Arora (Mohindra Capital Publisher, Chandigarh)  
 Engineering Geology : Parbin Singh  
 Structural Geology : H.P. Billings

**Name of Reference Books:** Geology and Engineering – Leggot, R.F. (Mc-Graw Hill, New York)  
 A Geology for Engineers – Blyth, F.G.M. (Arnold, London)  
 Civil Engineering Geology – Cyril Sankey Fox (C. Lockwood and son, U.K.)  
 Engineering and General Geology – Prabin Singh (Katson Publication House)

## SEMESTER IV

### 22CE01T: STRUCTURAL ANALYSIS-I

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit-I:** Principle of superposition, virtual work principle, Maxwell reciprocal theorem, deflection of beams using conjugate beam method. Deflection of beams and truss using energy method (Castigliano theorem), Analysis of plane truss using tension coefficient method (determinate),

**Unit-II:** Three-hinged Arches: Bending Moment, Shear force, axial force for three-hinged arches, Analysis of Suspension bridge without stiffening girders.

**Unit-III:** Influence Lines: Basic concept of moving load and influence line; influence lines for reactions, Shearing forces and bending moments for determinate beams; absolute maximum shearing force and bending moment.

**Unit-IV:** Influence lines for three-hinged arches and stresses in simply supported plane determinate trusses

**Unit-V:** Static and kinematic indeterminacy of structure, Method of structural analysis, Analysis of fixed beam, continuous beam using Theorem of three moments Effect of yielding of supports.

**Reference book:** Elementary structural Analysis by A.K. Jain  
 Advanced Structural Analysis by A. K. Jain

### 22CE02T : TRANSPORTATION ENGINEERING - I

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

#### UNIT 1

Introduction: Importance of highway transportation, Modes of transportation, characteristics of highway transport.

Historical development & planning: Historical development of roads, Road development and planning in India, Necessity of planning, Roads classification, patterns, Planning surveys.

Highway alignment and surveys: Engineering Surveys for highway location Maps and Drawing.

Highway drainage: Importance, Surface and subsurface drainage.

## **UNIT 2**

Geometric Design: Cross Section elements, Sight Distance, Design of horizontal and vertical Alignment.

## **UNIT 3**

Traffic Engineering: Traffic characteristics, studies such as volume, Speed, 'O' and 'D' and their uses, Traffic operations, Traffic control devices and prevention of road accidents Design of Intersections and parking facility, highway lighting, Traffic planning and administration.

## **Unit 4**

Highway Materials: Behavior of highway materials, properties of Subgrade and pavement component materials. Tests on subgrade soil, Aggregate and bituminous materials.

Pavement Design: Factors in design of flexible and rigid pavements, Design of flexible pavements: Group index, C. B. R. methods, I.R.C. recommended method, Design of Rigid pavement: Westergaard's analysis of wheel loads. Stresses in rigid pavements. I.R.C. recommendations Pavement Construction Techniques and Quality Control: Types of Pavements water bound macadam, bituminous and cement concrete pavements. Joints in cement concrete pavements, Pavement failures

## **UNIT 5**

Airport Planning: Definition of terms related to airport engineering, factors affecting site selection, obstructions, various surveys for site selection, zoning laws. Classification of Obstructions.

Runways: Orientation, Basic runway length and its corrections. Geometric design, runway configuration taxiways layout geometric, Standards, exit taxiways fillets separation.

### **Name of Text Books:**

Principle and Practices of Highway Engineering – Kadiyali & Lab (Khanna Publishers, Delhi)

Highway Engineering – S. K. Khanna & C.E.G. Justo (Khanna Publishers, Delhi)

Air-port planning and Design – Khanna and Arora (Khanna Publishers, Delhi)

Highway Engineering – Rangawala S.C. (Charotar Publishers)

A textbook of Transportation Engineering – S.P. Chandola (S. Chand)

Transportation Engineering – A.K. Upadhyay (S.K. Kataria & Sons)

### **Name of Reference Books:**

Specifications for Road and Bridge Works – MOST (IRC Publishers)

**Manual for Survey, Investigation and Preparation of Road Projects – IRC Publication 2001.**

**22CE03T : SURVEYING - II**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit 1**

**Triangulation:**

Principle and classification of Triangulation System, Triangulation chains, Strength of Figures, Station marks and Signals, Satellite station, intersected and Resected points, field work- Reconnaissance, Intervisibility of station, Angular measurement, Base line measurement and its extension.

**Unit 2**

**Tacheometry :**

Definitions, Principles of stadia systems. Instrument constants, Subtense and Tangential Systems. Construction and use of Reduction Tacheometers.

**Unit 3**

**Adjustment Computations:**

Weighting of observations. Treatment of random errors, probability equation, Normal law of error, Most Probable Value & measures of precision, Propagation of errors and variances. Most probable value, Principle of Least square, Observations and correlative Normal Equations. Adjustment triangulation figures and level nets.

**Unit 4**

**Photographic surveying:**

Photo theodolite, principle of the method of terrestrial photogrammetry, stereo Photogrammetry.

**Aerial surveying:**

Aerial surveying, scale and distortion of the vertical and tilted photograph, comparison between air photograph and map.

**Unit 5**

**Hydrographic surveying:**

Introduction, shore line survey, soundings methods, gauges, equipment required for hydrographic surveying.

**EDM :** Principle, Type, Use

**Text Books:**

Surveying (Vol. I & II) – Punmia, B.C. (Laxmi Publications, New Delhi, 1996)

Surveying (Vol. I & II) – Kanetkar T.P. (Pune Vidyarthi Griha Prakashan, Pune)

**Reference Books:**

Engg Surveying Technology – Kennie, T.J.M. and Petrie G. (Blackie & Sons Pvt. Ltd., London, 1990)

Surveying (Vol. II & III) – Agor, R (Khanna publications, Delhi, 1995)

Surveying (Vol. II & III) – Arora, K.R. (Standard Book House, Delhi, 1993)  
 Solving Problems in Surveying – Bannister A. and Baker, R. (Longman Scientific Technical)

## **22CE04T : FLUID MECHANICS - I**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**UNIT 1 Introduction:** Fluid, physical properties of fluids ideal and real fluid, Newtonian and Non-Newtonian Fluid

**Fluid Statics:** Pressure density height relationship, pressure measurement by Manometers, Pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, metacentric height.

**UNIT 2 Kinematics of fluid flow :** Steady and unsteady flow, uniform and non uniform flow, laminar and turbulent flow, one, two and three dimensional flow, streamlines and path lines, rotational and irrotational flow, continuity equation, three dimensional continuity equation. velocity potential and stream function.

**UNIT 3 Dynamics of fluid flow:** Euler’s equation of motion along a streamline and its integration, Bernoulli’s equation and its applications – Pitot tube, Venturimeter, orificemeter, problems related to application of momentum equations.

**UNIT 4 Flow in Pipes :** Major and minor losses in pipe lines, loss due to sudden contraction & expansion, Pipes in series and parallel

**Flow in open Channel:** Comparison between open channel and pipe flow, definition of uniform and non-uniform flow, Chezy’s and Manning’s Formula, Hydraulically efficient channel section of rectangular, trapezoidal .

**UNIT 5 Flow through mouthpieces and orifices:** Hydraulic coefficients of orifice, flow through large rectangular orifice, mouthpieces, Borda's mouthpieces.

**Notches and Weirs:** Rectangular, triangular and trapezoidal notches and weir, cippoletti and broad crested weir.

**Name of Text Books:**

- Fluid Mechanics and Machines – Dr. A.K. Jain (Khanna Publications)
- Fluid Mechanics and Machines – Dr. R.K. Bansal (Laxmi Publications)
- Fluid Mechanics & Hydraulic Machines – Dr. P.N. Modi & S.M.Seth, (Narosa Publishing House)

**Name of Reference Books:**

- Mechanics of Fluid – Irving H. Shames (McGraw Hill)
- Introduction to Fluid Mechanics – James A. Fay (Prentice Hall India)
- Fluid Mechanics – R.J. Garde (New Age International Publication)

Fluid Mechanics – Streeter V.L. & Wylie E.B. (Tata McGraw Hills)

Fluid Mechanics – John F Douglas (Pearson Publication)

Introduction to Fluid Mechanics Fox, R.W. and McDonald, A.T., John Wiley & Sons.

Fluid Mechanics”, Streeter, V.L. and Benjamin, W.E., “McGraw-Hill.

Fluid Mechanics and Fluid Mechanics Som, S.K. and Biswas, G.,Tata McGraw Hill.

Introduction to Fluid Mechanics, Fox, R. W. and A. T. McDonald, 6th ed., John Wiley, New York, (2004)

## **22CE05T : BUILDING CONSTRUCTION**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

### **UNIT 1:**

**Foundation: Functions of Foundation, essential requirements of a Good Foundation,** Preliminary Investigation of Soil, Bearing Capacity of Soil, Classification of Foundations, Introduction to Different type of foundation: Masonry footings, isolated footings, Combined and strap RCC footings, Raft footing, Pile foundations. Friction and Load bearing piles).

### **UNIT 2:**

**Masonry:** Definition of terms used in masonry, Bonds in Brickwork, English Bond, Flemish Bond, Reinforced brickwork, Joints in Stone Masonry, Rubble Masonry, Coursed Rubble Masonry, Uncoursed rubble masonry, Random rubble masonry, Ashlar Masonry, Masonry arches: Classification, Stability of an arch, Lintels, Types and classifications, Functions, Method of constructions, Chejja, Functions, Method of constructions, Canopy, Functions, Method of construction, Balcony, Functions, Method of construction, Shoring, Underpinning, Scaffolding

**UNIT 3: Floors and Roofs,** Types of flooring (Materials and method of laying), Granolithic, Mosaic, Ceramic, Marble, Polished Granite, Industrial flooring, Flat Roof (R.C.C.), Sloped roof (R.C.C. And Tile roof), Lean to roof, Wooden truss (King post and queen post trusses), Steel trusses, Weather proof course for RCC Roof,

### **UNIT4:**

**Stairs, Doors and Windows:** Types (Classifications) and Technical terms in stairs, Requirements of a good stair. Geometric Design of RCC Dog Legged and open well stairs. (Plan and sectional elevation of stairs), Doors, Types, Paneled doors, Glazed doors, Flush doors, Collapsible and rolling shutters, Louvered doors, Revolving, sliding and swing doors, Windows, Types, Paneled, Glazed, Bat window, Dormer window, Louvered and corner window, Ventilators .

**Plastering and Painting:** Purpose of Plastering, Materials of plastering, Lime mortar, Cement Mortar Methods of plastering, Stucco plastering, Lath plastering, Purpose of Painting, Types of Paints, Application of paints to new and old surfaces, Distemper, Plastic emulsion, Enamel, Powder coated painting to walls and iron and steel surfaces, Polishing of wood surface

#### **UNIT5:**

**Introduction to cost effective construction:** Necessity, Advantages, Pre fabrication techniques, Pre cast doors and windows (Pre cast frames, and shutters), Alternative Building Materials, Hollow concrete blocks, Stabilized mud blocks, Micro concrete tiles, Precast roofing elements

**Miscellaneous topics:** Form Work, Form work Details, RCC columns, Beams, Floors, Slip forming, Damp proof construction

#### **TEXT BOOKS**

1. **Building Construction** by S.G. Rangwala, Charter Publishing House, Anand, India.
2. **Building Construction** by Sushil Kumar, Standard Publication and Distributors, New Delhi
3. **Building Construction** by Punmia B.C., Lakshmi Publications, New Delhi.
4. **Advanced Building Materials and Construction** by Mohan Rai and Jai Sing, CBRI Publications, Roorkee.

## SEMESTER V

### **31CE01T : STRUCTURAL ANALYSIS-II**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit-I:** Analysis of indeterminate beams by Consistent Deformation methods, Analysis of indeterminate rigid plane frames and truss using energy method.

**Unit-II:** Slope Deflection Method: Continuous beams and portals by moment distribution due to load and yielding of supports.

**Unit-III:** Moment-distribution method. Continuous beams and portals by moment distribution due to load and yielding of supports.

**Unit-IV.** Introduction to Flexibility matrix and Stiffness Matrix methods: Applications of the methods to simple indeterminate beams.

**Unit-V:** Analysis of symmetrical two hinge arches (parabolic and circular). Influence lines for propped cantilevers, continuous beams using Muller-Breslau's principle.

*Reference book: Indeterminate Structural Analysis by C. K. Wang*

*Fundamental of Structural Analysis by Leet.*

### **31CE02T : DESIGN OF CONCRETE STRUCTURES - I**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit – I:** Introduction to design of concrete structures-limit state analysis and design of beams for flexure, bond.

**Unit- II:** Shear and torsion

**Unit-III:** one way slabs, stair cases, Two-way slabs

**Unit- IV:** Axially and eccentrically loaded columns (uni-axial only)

**Unit-V:** Footings – different types of isolated footings, synthesis of limit state and working Stress methods.

*Reference book: Reinforced Concrete Design by Pillai & Menon*

*Limit State Design of Reinforced Concrete by P.C. Verghese*



## **31CE03T : FLUID MECHANICS - II**

			SESSIONAL - TA			ESE
T	P	IA	MSE	TOTAL		
3	1	-	20	20	40	60

### **Unit 1: Turbulent flow in pipe**

Nature of turbulence, free and wall turbulence, turbulent flow in pipes, equation for velocity distribution over smooth and rough surfaces, Colebrook-White equation, Moody's diagram, Explicit equation for friction factors.

### **Unit 2: Boundary layer Analysis**

Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, turbulent boundary layer, and laminar sub layer, Application of momentum equation, local and average friction coefficient.

Fluid flow past submerged bodies

Drag and lift, drag on sphere and cylinder Magnus effect.

### **Unit 3: Non-uniform flow in open channel**

Specific energy, critical flow, analysis of flow over hump and transition, equation of gradually varied flow, hydraulic jump and evaluation of its elements in rectangular channel.

### **Unit 4: Compressibility effect in pipe flow**

Transmission of pressure waves in rigid and elastic pipes, water hammer

Dimensional analysis and Hydraulic similitude

Dimensional analysis, Buckingham's theorem, important dimensionless numbers and their significances, geometric, kinematics and dynamic similarity, model study.

### **Unit 5: Hydraulic Machines**

Turbines: Classification of turbines, draft tube, specific speed, unit quantities, and characteristics curves of turbines, and governing of turbine.

Pump: Introduction, Centrifugal pumps, efficiencies, specific speed, cavitations, slip, percentage slip

#### **Name of Text Books:**

Fluid Mechanics and Machines – Dr. A.K. Jain (Khanna Publications)

Fluid Mechanics and Machines – Dr. R.K. Bansal (Laxmi Publications)

#### **Name of Reference Books:**

Fluid Mechanics – Dr. P.N. Modi (Standard Book House)

Mechanics of Fluid – Irving H. Shames (McGraw Hill)

Introduction to Fluid Mechanics – James A. Fay (Prentice Hall India)

Fluid Machines – Dr. Jagdish Lal (Metropolitan Book Company Private Ltd.)

Fluid Machines – John P. Douglas (Pearson Publication)

## 31CE04T : GEOTECHNICAL ENGINEERING - I

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit-I:** Introduction, Classification of soils, Soil compaction. Effective stresses, Surface tension and Capillarity

**Unit-II:** Permeability of soils, Seepage analysis.

**Unit-III:** Stress distribution in soils, Compressibility and consolidation, soil compaction.

**Unit-IV:** Shear strength of soils, Earth pressure theories.

**Unit-V:** Stability of slopes, Sub-soil exploration, Design principles of shallow and deep foundation.

*Reference book: Geotechnical Engineering by B. M. Das, Bharat Singh, Samsher Alam  
Geotechnical Engineering by S. K. Gulathi & Dutta  
Soil Mechanics by Lambe & Whitman  
Soil Mechanics by B.C.Punamia,*

## 31CE05T : TRANSPORTATION ENGINEERING - II

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

### UNIT 1

Necessity, classification and systems of Railways, Historical Development of railways in India.

Alignment and Survey: Track Alignment, Requirements of good alignment, Factor affecting alignment, Surveys.

Permanent Way: Introduction, Component parts, Requirement of Permanent Way, Typical Cross-section.

Gauge: type & factor affecting.

### UNIT 2

Rails: Function, Type, Weight, Selection, Length of rails, Rails joints: type & requirement, Coning of wheels, Tilting of rails, Roaring of rails, Creep of rails, Wear of rails, Welding of rails.

Sleepers: Requirements of an ideal sleeper, functions, types, sleeper density.

Ballast: Function, characteristics, types, size and section, quantity.

Fixtures & Fastenings: Function, types.

### UNIT 3

Geometrics: Terms related to cross section, typical cross section, Gradient, Grade composition of curves, Curves, Super-elevation, cant deficiency, Negative cant, widening of gauges on curves.

### UNIT 4

Points and Crossings: Necessity, Important technical terms in point and crossings.

Turnout: Component parts and functions.

Crossing: Component parts, requirement, types. Points and switches: Types. Track junctions: Types. Signaling: Object, type. Station & yards: Introduction, Types of stations, platforms, minimum horizontal, yards level crossing.

## UNIT 5

Tunnel Engineering: Consideration in tunneling shape and size, methods of tunnel, constructions, tunneling in soft soil and rocks, lining of tunnels, ventilations, drainage of tunnels. Harbour Engineering: Harbour of early period, Dry docks and spillways, warehouses, Quays, jetties, wharves, piers and berthing facilities, maintenance of ports and harbours.

### Name of Reference Books:

Railway Engineering – S.C. Saxena & Arora (Dhanpat Rai Publications)  
A textbook of Transportation Engineering – S.P. Chandola (S. Chand)  
Transportation Engineering – A.K. Upadhyay (S.K. Kataria & Sons)  
Tunneling Engineering – S.C. Saxena (Dhanpat Rai Publications)  
Railway Engineering – Rangawala (Charotar Publications)  
Harbour Engineering – Srinivas  
Tunnel and Harbour – Seetharaman S. (Umesh Publications)

## SEMESTER VI

### **32CE01T : DESIGN OF STEEL STRUCTURES**

	T	P	SESSIONAL - TA			ESE
			IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit-I:** Introduction-Building system, Load Path, Loading as per IS 875, load combinations; Design philosophy-Rolled Sections and Built-up sections; Connections-Welded and Riveted

**Unit-II:** Failure Modes; Design of Tension, Compression Members-effective length, buckling Load

**Unit-III:** Design of Flexural Members-Lateral Buckling; Design of Built-up column using lacing and batten plates. Design of column bases

**Unit-IV:** Design of Anchor bolts, Design of plate Girder and Gantry Girder. Industrial Structures

**Unit-V:** Elements of Plastic Design: Introduction, plastic hinges, shape factor, load factor, collapse loads for beams and portals, effect of axial force and shear on the plastic moment of the section, uniqueness

*Reference books: Design of Steel Structures by-S. K. Duggal.*

*Design of Steel Structures by- B. C. Punmia & A. K. Jain.*

### **32CE02T : GEOTECHNICAL ENGINEERING - II**

	T	P	SESSIONAL - TA			ESE
			IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit-I:** Analysis and design of Shallow Foundations, Foundation failure (Case histories)

**Unit-II:** Pile foundations, Foundations on problematic soils

**Unit-III:** Shoring and underpinning, Mat foundation

**Unit-IV** Pier and Caisson foundation, Cofferdam, Diaphragm walls

**Unit-V:** Environmental aspects for design/protection of foundation structures

*Reference Books: Basic & Applied Soil Mechanics. by- Gopal Ranjan & A. S. R. Rao  
Foundation Analysis & Design by - J. E. Bowles*

## **32CE03T: ENVIRONMENTAL ENGINEERING - I**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

### **UNIT 1: Introduction**

Necessity and importance of water supply schemes.

#### **Water demand**

Classification of water demands, Estimation of quantity of water required by a town, per capita demand, factors affecting per capita demand, design period and population forecasting, variation in water demand.

#### **Sources of water supply**

Surface sources and underground sources, Intake works, site selection, type of intake works.

### **UNIT 2: Quality of water**

Common impurities, physical, chemical and biological characteristics of water, water quality standards for municipal and domestic supplies.

#### **Water Processing**

Object of water processing, flow diagrams of typical ground water system and surface water systems. **Sedimentation**

Theory of sedimentation, sedimentation tanks and its types, design parameters related with sedimentation tanks, sedimentation with coagulations, coagulants and coagulant aids, Jar test for determining coagulant dosage.

### **Unit 3 Filtration**

Theory of filtration, slow sand and rapid sand filters, Construction and operation.

#### **Disinfection**

Methods of disinfection, Chlorination, Types of chlorination, Break Point chlorination.

### **Unit 4 Softening**

Methods of Softening, Iron Removal, Fluoridisation.

### **Distribution System**

Methods of distribution, layout of distribution system, methods of analysis, pressure in the distribution system, distribution reservoirs, functions and its types, storage capacity of distribution reservoir.

### **Unit 5 Air Pollution**

Introduction, causes, sources, characteristics, effects of air pollution on plants, humans, animals and materials and atmosphere, air pollution control methods and equipment.

### **Noise Pollution**

Definition, sources, effects of noise pollution on humans, animals and non-living things, methods of noise control.

### **Name of Text Books:**

Water Supply Engineering – S.K. Garg (Khanna Publication).

Water Supply Engineering – B.C. Punmia (Laxmi Publication, New Delhi)

### **Name of Reference Books:**

Environmental Engineering – Peavy & Rowe (Tata McGraw Hill, New Delhi).

Water Supply and Sanitary Engineering – G.S. Birdi (Dhanpat Rai Publications).

Introduction to Environmental Science – Y. Anjaneyulu (B.S. Publications)

Environmental Science and Engineering – Henry and Heinke (Pearson Education)

## **32CE04T: WATER RESOURCES ENGINEERING - I**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

### **Unit 1**

#### **Introduction**

Need for Irrigation, Advantages and Disadvantages of irrigation, Types of Irrigation systems – Flow Irrigation, Lift Irrigation

#### **Methods of Irrigation**

Introduction, requirement of irrigation methods, surface and sub surface irrigation

#### **Water Requirement of Crops**

Introduction, Water requirement of crop, crop season and crops of India, crop period and base period, delta, duty of water, relationship between delta duty and base period, factors affecting duty.

## **Unit 2**

### **Canal Irrigation**

Classification of canal, parts of canal irrigation system, canal alignment, typical canal cross section, command areas, losses in irrigation systems.

### **Design of Stable Channels in Alluvium**

Introduction, Kennedy's silt theory, Lacey's Theory, Lacey's regime equations, Lacey's shock theory, Design of channels by Kennedy's and Lacey's theories, maintenance of Irrigation channels.

## **Unit 3**

### **Water Logging and its Control**

Causes and ill effects of water logging, prevention and control, reclamation of water logged lands, surface drainage.

### **Design of Lined Channels**

Introduction, benefits of lining, types of lining, economics of lining, procedure and design of lined canals.

## **Unit 4**

### **River Behavior, Control and Training**

Objects, river characteristics, river patterns, classification of river training works, methods of river training embankments, bank protection, cutoffs, meandering causes and parameters

### **Flood Control**

Introduction, levees and embankments, channel improvement, flood ways evacuation and flood plain zoning, National Policy of floods.

## **Unit 5**

### **Reservoir Planning**

Introduction, Type of reservoirs, storage zones of a reservoir, mass curve and demand curve, determination of reservoir capacity, safe field.

### **Flood Routing**

Flood Routing principle, inflow storage discharge method, reservoir losses, reservoir sedimentation, life of reservoir,

Name of Text Books:

Irrigation Engineering and Hydraulic Structures – S.K. Garg (Khanna Publications)

Irrigation Engineering – B.C. Punmia (Laxmi Publications)

### **Name of Reference Books:**

Irrigation, Water Resources and Water Power Engineering – Dr. P.N. Modi (Standard Book House)

Theory and Design of Irrigation Structures (Volume – I & II) – Varshney (Nem Chand & Bros.)

Irrigation and Water resources Engineering – Asawa G.L. (New Age International Publications)

Fundamentals of Irrigation Engineering – Bharat Singh (Nem Chand & Bros)

Water Resources Engineering Larry -W. Mays (Wiley, John & Sons)

## 32CE05T : ESTIMATING & COSTING

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit-I:** Method of estimating, measurements, taking out quantities.

**Unit-II:** Typical estimates for buildings and Civil Engineering Works, Specifications for all types building items.

**Unit-III:** Analysis of rates, data for various building items.

**Unit-IV:** Earthwork calculations.

**Unit-V:** Introduction to Departmental procedures, tender, contracts, arbitrations, valuation of buildings.

*Reference Books: B.N Dutta, Estimating and Costing in Civil Engineering Theory and Practice*

*M. Chakraborti, Estimating, Costing and Specifications in Civil Engineering.*

## SEMESTER VII

### CE41T01 : STRUCTURAL ENGG. DESIGN - III

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

#### **Unit 1** Plate Girders

Bolted and Welded Plate Girders - Design of cross-section, curtailment of flange plates, stiffeners, splices.

#### **Unit 2** Connections

Simple, Semi-rigid and Rigid Connections, Connection Configurations, Framed and seated connections, Moment resistant connections.

#### **Unit 3** Fabrication and Erection

Fabrication Operations, various processes for joining, forming, cutting and welding, Inspection of fabrication, Code provisions for tolerances and deviations, Principle of erection, Erection organisation, Assembly marks, Code provisions for erection, allowable tolerances for plumbing, levelling and alignment.

#### **Unit 4** Industrial Buildings

Various components of an industrial building, Loads and load combinations, Design of purlins, roof trusses, Industrial building frames, gantry girder and bracings.

#### **Unit 5** Steel Bridges

Plate girder and Truss Bridges, General arrangement, Design loads for Highway / Railway steel bridges, Design of Truss bridge for Railway loading.

**Name of Text Books:**

Design of Steel Structures – B.C. Punmia, Jain & Jain (Laxmi Publication, New Delhi)  
 Design of Steel Structures – A.S. Arya and J.L. Ajamani (Nemchand and Bros., Roorkee)

**Name of Reference Books:**

Design of Steel Structures (Vol. - I & II) – Ram Chandra (Standard Book House, New Delhi)  
 Design of Steel Structures – Dayaratnam (Wheeler Publishing, New Delhi)  
 Design of Steel Structures – E.H. Gaylord and C.N. Gaylord (Mc Graw Hill, New York)  
 Steel Structures: Design and Behaviour – C.G. Salmon and J.E. Johnson (Harper and Row, New York)

**CE41T02 : ENVIRONMENTAL ENGINEERING – II**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit - I** Objective, design period, Physical, Chemical and Biological characteristics. Waste water sampling, Self-purification of natural streams, Stream standards, effluents Standards, Oxygen Sag Curve, Sources of sewage, storm-water runoff, Design of sanitary sewers, Minimum size of sewer, velocities in sewers and gradient of sewers. Sewer appurtenances i.e. manholes, street inlets, flushing devices, Vent pipes etc.,

**Unit - II Waste Water primary Treatment:** Types of screens, design of screen chamber, disposal of Screenings, Sources of grit, velocity control in grit chamber, design of grit chambers including proportional flow weir, disposal of grit, Oil and grease removing skimming tanks, Design of PST with inlet and outlet details, Primary Sludge and its disposal

**Unit - III Aerobic Treatment Units :** Biological principle of ASP, SVI, sludge bulking and control; Biological principle of **Trickling filter**, Re-circulation, Ventilation, Operational troubles.; Rotating Biological Contactor.

**Low Cost Treatment methods: Principle of** Oxidation pond, symbiosis, principle of Aerated Lagoons, aeration method, Principle of Oxidation Ditches, sewage farming, ground water recharge etc.

**Unit v- IV Anaerobic Treatment Units :** Septic tanks, biological Principle, method of treatment and disposal of septic Tank effluent. Anaerobic Digester, principle of anaerobic digestion, Stages of digestion, Bio-gas production, Sludge disposal methods, advantages and disadvantages



**UNIT - V Solid waste management, source and characteristics, environmental and health implications, refuse characteristics, collection methods, disposal of solid waste by land filling, composting and incineration methods. Hazardous waste management: Exposure and risk assessment, incineration, landfill disposal, site remediation. Collection and disposal of refuse, Composting of refuse.**

**Name of Text Books:**

1. Environmental Engineering – Peavy & Rowe (Tata McGraw Hill, New Delhi).
2. Waster Water Engineering – S.K. Garg (Khanna Publication).
3. Manual on sewerage & sewage Treatment published by Ministry of Urban Dev. GOI.,Ministry of Urban development

**Name of Reference Books:**

1. Waste Water Engineering – Metcalf Eddy (Tata McGraw Hill, New Delhi).
2. Hazardous Waste management : M.D. LaGrega, P.L. Buckingham, J.C.Evans
3. Manual on Municipal Solid Waste Management : CPHEEO (Ministry of Urban Development.
4. Environmental Engineering - II. P. Venugopala Rao Tata McGraw Hill Publication,2003
5. Water and Wastewater Technology ,Hammer

**CE41T03 : Water Resources Engineering – II**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

**Unit 1** Types of Dams, Forces, failure of dams and criteria for structural stability, principal and shear stress, stability analysis, Elementary profile of a gravity dam, Profile from practical considerations, Openings in dams and Function of opening

**Unit 2** **Spillways and Energy Dissipaters**

Introduction, essential requirements of a spillway, spillway capacity, components, Types of spillways, Ogee Spillway, Energy Dissipation below spillways, Types of Energy dissipater, USBR stilling basins

**Unit 3** **Diversion Head-works**

Introduction, Types of diversion works, location and components, Weir and Barrage, Effect of construction of weir on the river regime, Bligh’s creep theory, Theory of seepage flow, Khosla’s theory, Vertical drop Weir.

**Unit 4** **Regulation Works**

Introduction, Definition of falls, necessity and location of falls, comparative study of the main types of falls, Cross regulator.

**Hydraulic Gates**

Control equipments for out-lets, spillway gates, types, design criteria for radial gates.

## **Unit 5**      **Cross Drainage Works**

Introduction, suitability, various types of C-D Works, Design principles of C-D Works

### **Name of Text Books:**

Irrigation Engineering and Hydraulic Structures – S.K. Garg (Khanna Publications)

Irrigation Engineering – B.C. Punmia (Laxmi Publications)

### **Name of Reference Books:**

Irrigation, Water Resources and Water Power Engineering – Dr. P.N. Modi (Standard Book House)

Theory and Design of Irrigation Structures (Volume – I & II) – Varshney (Nem Chand Bros.)

Irrigation Engineering – Asawa G.L. (New Age International Publications)

Fundamentals of Irrigation Engineering – Bharat Singh (Nem Chand & Bros.)

## **CE 41T04 : DESIGN OF PRESTRESSED CONCRETE**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

### **Unit-I**      **Methods, Systems and Materials**

Basic principles, methods and systems of prestressing, external, internal, full, partial, pre-tensioning and post-tensioning, quality of concrete and steel, I.S. Code provisions for allowable stresses, Advantages of prestressing and importance of high strength materials.

### **Unit-II**      **Analysis of Structures for Flexure**

Cases of axial and eccentric prestressing allowing suitable percentage loss of prestress. Stresses in concrete at various stages, lever arm concept and center of pressure, pressure line, kern distances, load balancing cable profiles, critical span (for solid slabs only), Efficiency of a section.

### **Unit -III**      **Losses of Prestressing**

Various types of losses of prestress and their calculation, loss due to friction, I.S. Code provisions, Elastic shortening due to successive tensioning of cables.

#### **Design of section for flexure**

I.S. Code provisions for cover and spacing, standard Fressinet and Gifford Udall cables, Design of beams and slabs, cable zones and profiles.

### **Unit -IV**      **Composite Beams**

Different types, Loading conditions, analysis for stresses, differential shrinkage.

#### **BOND AND ANCHORAGE**

Bond stress and its significance in pre-tensioned beams, transmission length, determination of bursting force due to anchor zone stresses and provision of steel according to I.S. Code for prestressed concrete.

## Shear

Calculation of diagonal tension and its inclination (including vertical prestressing also) provision of steel according to elastic method and I.S. Code method, advantages of prestressing.

## Unit-V Limit State Design

Limit state of serviceability and strength, calculation of ultimate bending moment for given sections, advantages of limit state method over working stress method.

## Miscellaneous uses

Analysis and design of poles and circularly prestressed pipes and tanks.

## **NAME OF TEXT BOOKS:**

Prestressed Concrete – Krishna Raju N. (New Age International)

Prestressed Concrete -

## **CE41T05: THEORY OF PLATE & SHELLS**

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

Unit-1: Simple bending of Plates-Assumptions in thin plate theory-Different relationships-Different, Boundary Conditions for plates- Plates subjected to lateral loads – Navier’s method for simply supported plates – Levy’s method for general plates – Example problems with different types of loading.

Unit-2: Circular plates subjected to Axi-symmetrical loads–concentrated load, uniformly distributed load and varying load – Annular circular plate with end moments.

Unit-3: Rayleigh-Ritz method – Application to different problems – Finite difference method – Finite element methodology for plates-Orthotropic Plates

Unit-4: Bending of anisotropic plates with emphasis on orthotropic plates – Material Orthotropy – Structural Orthotropy - Plates on elastic foundation.

Unit-5: Shells- Classification of shells - Membrane and bending theory for singly curved and doubly curved shells - Various approximations - Analysis of folded plates

References

1. Rudolph Szilard, Theory and Analysis of Plates, Prentice Hall, New Jersey 1986.

## **CE41T06: THEORY OF ELASTICITY & PLASTICITY**

Basic concepts of deformation of deformable bodies- Notations of stress and strain in a 3D field Transformations of stresses and strains in Cartesian and polar co-ordinates- Equilibrium equations in two and three dimensions in Cartesian co-ordinates.

Plane stress and plane strain problems - Two dimensional problems in Cartesian co-ordinates as applied in beam bending, using Airy's stress function - Polar co-ordinates. Equations of equilibrium and compatibility-Two dimensional problems in polar co-ordinates-Stress concentration in holes.

Energy principle -theorem of minimum potential energy and complementary potential energy- Torsion of various shaped bars- Prandtl’s membrane analogy- energy method- Torsion of rolled Profiles- Stress concentration at re-entrant corners.

Introduction, yield criteria for metals, graphical representation of yield criteria, Flow laws of

plastic mass, Plastic strain relations-Application to thick cylinders - Hollow spheres -Torsion.

References

1. Timoshenko and Goodier, Theory of Elasticity, McGraw-Hill, 2006.
2. Wang, Applied Elasticity, Dover Publications Inc. Newyork.1985.
3. W.F. Chen and D.J. Pan., Plasticity for Structural Engineers, Springer Verlag 1998.

## **CE41T07: REHABILITATION OF STRUCTURES**

Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking. Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection Definitions: Maintenance, repair and rehabilitation, Facets of and importance of Maintenance Preventive measures on various aspects Inspection, Assessment procedure for evaluating a damaged structure causes of deterioration-testing techniques. Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fiber reinforced concrete. Rust eliminators and polymers coating for rebars during foamed concrete, mortar repair for cracks, shoring and underpinning.

**References**

1. Raikar, R.N., Learning from failures – Deficiencies in Design, Construction and Service – R&D Centre (SDCPL), Raikar Bhavan, 1987.
2. Allen R.T., and Edwards S.C, Repairs of Concrete Structures, Blaike and Sons, U.K.1987.

## **CE41T08 : ADVANCED STRUCTURAL ANALYSIS**

Unit-I Direct stiffness method Introduction - element stiffness matrix - rotation transformation matrix - transformation of displacement and load vectors and stiffness matrix - equivalent nodal forces and load vectors - assembly of stiffness matrix and load vector - determination of nodal displacements and element forces - analysis of plane truss - plane frame (with numerical examples) - analysis of grid - space-truss and space-frame (without numerical examples) - computer Implementation - introduction to analysis packages

(A project on development of an analysis program using above method is envisaged at this stage)

Unit-II Beams on elastic foundation: general theory - infinite beam subjected to concentrated load - boundary conditions - infinite beam subjected to a distributed load segment - semi-infinite beam subjected to loads at its end - semi-infinite beam with concentrated load near its end - short beams.

Unit-III Beams curved in plan: Analysis of cantilever beam curved in plan - analysis of circular beams over simple supports

Unit-IV Nonsymmetrical bending of straight beams: Shear centre – a review, symmetrical and nonsymmetrical bending - bending stresses in beams subjected to nonsymmetrical bending - deflections of straight beams subjected to unsymmetrical bending - fully plastic load for unsymmetrical bending.

Unit-V Introduction to Structural Dynamics

Single degree of freedom – undamped and damped vibration-free vibration - forced vibration, introduction to multi degree of freedom systems.

References

1. Wang, C. K., Matrix Methods of Structural Analysis, International Textbook Company, 1970.

2. Przemieniecki, J. S., Theory of Matrix Structural Analysis, McGraw Hill, New York, 1985.
3. Weaver, W., and Gere, J. M., Matrix Analysis of Framed Structures, CBS Publishers, 2004.
4. Rajasekaran, S., and Sankarasubramanian, G., Computational Structural Mechanics, PHI
5. Boresi, A. P. and Sidebottom, O. M., Advanced Mechanics of Materials, John Wiley and Sons, 2003.
6. Srinath, L. S., Advanced Mechanics of Solids, Tata McGraw Hill, 2009.
7. Timoshenko, S., Strength of Materials, Part II, CBS Publishers, 2002.
8. Reddy, C. S., Basic Structural Analysis, Tata McGraw Hill, New Delhi, 2007.
9. Paz M., Structural Dynamics, CBS Publishers, 2007.
10. Meirovich, L., Elements of Vibration Analysis, McGraw Hill, 2007.

## **CE41T09 : STRUCTURAL DYNAMICS**

Unit- 1. INTRODUCTION: Comparison between static and dynamic analysis; Degrees of freedom; Undamped system; Newton's law of motion; 'D' Alembert's principle; Solution of the differential equation of motion.

Unit-2. FREE VIBRATION OF SINGLE DEGREE - OF - FREEDOM SYSTEM: Equation of motion for single degree - of - freedom system; Free un damped vibration of the SDOF system; Damped single degree - of - freedom system -Viscous damping, Equation of motion, Critically damped system, Over damped system. Under damped system and Logarithmic decrement.

Unit-3. RESPONSE OF SDOF SYSTEM TO HARMONIC LOADING: Undamped harmonic excitation; Damped harmonic excitation; Evaluation of damping at resonance; Response to support motion; Force transmitted to the foundation.

RESPONSE OF SDOF SYSTEM TO GENERAL DYNAMIC LOADING: Impulsive loading and Duhamel's integral; Numerical evaluation of Duhamel's integral — undamped system; Numerical evaluation of Duhamel's integral -Damped system.

Unit-4. GENERALIZED COORDINATES AND RAYLEIGH'S METHOD: Principle of virtual work; Generalized SDOF system - Rigid body; Generalized SDOF system - Distributed elasticity; Rayleigh's method; Improved Rayleigh's method.

Unit-5 STRUCTURES MODELED AS SHEAR BUILDINGS: Stiffness equations for the shear building; Flexibility equations for the shear building; Free vibration of a shear building (Single bay two Storeyed) - Natural frequencies and normal modes.

FORCED MOTION OF SHEAR BUILDINGS (Two Storeyed): Modal superposition method; Response of a shear building to base motion; Harmonic forced excitation.

## **CE41T10 : EARTHQUAKE RESISTANT DESIGN OF STRUCTURES**

UNIT-I 1) Elements of structural dynamics

Sources of vibrations; Types of vibrations; Degrees of freedom; Spring action and damping; Free vibration of undamped system having single degree of freedom; Free vibration of viscous damped system having single degree of freedom; Forced vibration of a viscous damped single degree freedom system subjected to harmonic excitation; Earthquake excitation (Base excitation) of a single degree freedom system.

UNIT-II 2) Elements of Earth Quake Ground motion

Earthquake size- Intensity and magnitude; Seismic Zoning-Introduction; Strong Motion Earthquakes - Introduction; Response spectrum (elastic); Local site effect (Effect of type of soil).

### 3) Elements of Geotechnical Earthquake Engineering

Liquefaction – Definition and types, Effect of liquefaction on built environment, Evaluation of liquefaction susceptibility, Liquefaction hazard mitigation

Seismic slope stability – Introduction, Pseudo-static analysis, Sliding block methods

UNIT III 4) Analysis of single storey and single bay RCC Plane Frame (Columns vertical) : (As per IS:1893(part-I)-2002)

Calculation of lateral force due to earthquake using equivalent static method ; Analysis for different load combinations; Design forces and moments in beam and columns.

UNIT-IV 5) Design of single storey and single bay RCC plane frames (Columns vertical)

(As per IS:456-2000 and IS13920-1993)Design of column; Design of beam; Design of footing ; Detailing of entire frame

Unit-V 6) Masonry Structures :House types and damages, cause and location of damage, Understanding the knowledge hidden in your existing houses, Making houses earthquake resistant, Earthquake resistant features, Retrofitting-some examples, Technology choice, summary of earthquake resistant features, improving housing designs.

TEXT BOOKS: 1)Elements of Earthquake Engineering by Jai Krishna, A.R.Chandrasekaran and Brijesh Chandra, Second Edition(1994), South Asian Publishers, New Delhi. (For Chapters 1 and 2)

2) Geotechnical Engineering - S.K.Gulati & Manoj Datta, Tata McGraw-Hill Publishing Company Ltd. (For Chapter 3)

3)Earthquake Resistant Design of Structures by Pankaj Agarwal, Manish Shrikhande , First edition(2006), Prentice Hall of India Private Ltd., New Delhi . (for Chapters 1,2,4 and 5)

4) Earthquakes and Buildings – A.S.Arya, A.Revi, Pawan Jain (For Chapter-6)

CODES IS:1893(part-I)-2002 - IS13920-1993 - IS:456-2000 - SP16

REFERENCE BOOK Dynamics of Structures by A.K.Chopra, Second edition (2001), Prentice Hall India Private Ltd

## **CE41T11 : FRACTURE OF CONCRETE STRUCTURES**

Unit I Concepts of linear elastic fracture mechanics,

Unit-II Principles of Nonlinear fracture mechanics and energy balance approach

Unit-III Behaviour of materials like concrete under fracture load and fracture process of concrete

Unit-IV Nonlinear fracture properties of concrete using different models, Modeling and applications of nonlinear fracture models, R-curve behavior of concrete,

Unit-V Test methods for determining fracture parameters of concrete, Fracture mechanics applications to concrete structures.

### References:

Anderson TL (2005) Fracture Mechanics Fundamentals and Applications. CRC Press, Taylor & Francis Group, Boca Ranton.

Bazant ZP, Planas J (1998) Fracture and size effect in concrete and other quasibrittle materials, Florida: CRC Press.

Karihaloo BL (1995) Fracture mechanics and structural concrete, Concrete Design and Construction Series, Longman Scientific & Technical, Harlow, Essex, England.

Kumar S. and Barai S.V. (2011). Concrete Fracture Models and Applications. ISBN 9783642167638 (Hard Cover), Springer.

## **CE41T12 : ADVANCED STEEL DESIGN**

Unit-I Gantry Girder Design of gantry girder – gantry to column connection.

Water Tanks Design of rectangular, pressed steel tanks – design of suspended bottom tanks – cylindrical tank with hemispherical bottom – design of staging.

Unit-II Chimneys

Design of self supporting chimney – design principles of guyed chimney.

Bunkers and Silos

Introduction– Janssen’s theory– Airy’s theory– design criteria.

Unit-III Transmission Towers

Introduction–loads on towers– analysis–design of members and foundation.

Unit-IV Plate girder bridges

Plate girders – loads – equivalent uniformly distributed loads – Indian railway code of practice – design of plate girder bridges – bearings.

Unit-V Light gauge members

Light gauge sections – design considerations – allowable stresses – buckling, design of compression members, tension members and laterally supported beams – connections.

### **References**

1. Subramanian, N., Design of Steel Structures, Oxford University Press, 2008
2. Bhavikatti, S. S., Design of Steel Structures, I K International Publishing House (P) Ltd.
3. Duggal, S. K., Limit State of Design of Steel Structures, Tata McGraw Hill, 2010.
4. Ramchandra , Design of Steel Structures Vol I and II, Standard book house , 1991
5. Dayaratnam, P., Design of Steel Structures, Wheeler,1998
6. Raghupathi, M., Design of Steel Structures, Tata McGraw Hill, 1985
7. Lin and Breslar, Design of Steel Structures, John Wiley and Sons, 1963
8. Relevant BIS codes ( IS 800, SP 6,IS 804, IS 805,IS 6533, IS 9178, IS 801,IS 811 )

## **CE41T13 : ADVANCED CONCRETE DESIGN**

Unit I: Large span concrete roofs

Introduction– classification- behaviour of flat slabs - direct design and equivalent frame method- codal provisions - waffle slabs.

Unit II: Shells and Folded plates

Forms of shells and folded plates- structural behaviour of cylindrical shell and folded plate- method of analysis membrane analysis – beam arch approximation- codal provisions- design of simply supported circular cylindrical long shells and folded plates.

Unit-III: Deep beams

Analysis of deep beams- design as per BIS - design using strut and tie method.

Unit-IV: Chimneys

Analysis of stresses in concrete chimneys- uncracked and cracked sections- codal provisions- design of chimney. Water tanks: Introduction- rectangular and circular with flat bottom- spherical and conical tank roofs- staging- design as per BIS.

Unit-V :Bridges

General – IRC Bridge code –loading standards–impact effect – wind load – longitudinal forces – centrifugal forces –force due to water currents – buoyancy effect – temperature effects – secondary stresses – erection – seismic force

Design of slab culvert – R.C box culverts –T-beam bridges – Concept on design of continuous bridges, balanced cantilever bridges, arch bridges and rigid frame bridges.

### **References**

1. Purushothaman, P., Reinforced Concrete Structural Elements-, Tata McGraw Hill, 1986
2. Ramaswamy, G. S., Design and Construction of Concrete Shell Roofs-CBS publishers, 1986
3. Ashok K Jain, Reinforced Concrete –Nem Chand Bros. Roorkee , 1998
4. Jain and Jaikrishna, Plain and Reinforced Concrete – Vol I and II, NemChand Bros., Roorkee, 2000.
5. Taylor C Pere, Reinforced Concrete Chimneys, Concrete publications, 1960
6. Design of deep girders, Concrete Association of India, 1960
7. Mallick and Gupta, Reinforced Concrete, - Oxford and IBH, 1982
8. BIS codes ( IS 456 , IS 2210, IS 4998, IS 3370, SP 16, SP 24, SP 34).
9. IRC Codes (IRC 5, IRC 6, IRC 21)

## **CE41T14 : ADVANCED CONCRETE TECHNOLOGY**

### UNIT - 1

Importance of Bogue's compounds, Structure of a Hydrated Cement Paste, Volume of hydrated product, porosity of paste and concrete, transition Zone, Elastic Modulus, factors affecting strength and elasticity of concrete, Rheology of concrete in terms of Bingham's parameter. CHEMICAL ADMIXTURES- Mechanism of chemical admixture, Plasticizers and super Plasticizers and their effect on concrete property in fresh and hardened state, Marsh cone test for optimum dosage of super plasticizer, retarder, accelerator, Air-entraining admixtures, new generation superplasticiser. MINERAL ADMIXTURE-Fly ash, Silica fume, GCBS, and their effect on concrete property in fresh state and hardened state.

### UNIT - 2

MIX DESIGN - Factors affecting mix design, design of concrete mix by BIS method using IS10262 and current American (ACI)/ British (BS) methods. Provisions in revised IS10262-2004.

### UNIT - 3

DURABILITY OF CONCRETE - Introduction, Permeability of concrete, chemical attack, acid attack, efflorescence, Corrosion in concrete. Thermal conductivity, thermal diffusivity, specific heat. Alkali Aggregate Reaction, IS456-2000 requirement for durability.

### UNIT - 4

RMC concrete - manufacture, transporting, placing, precautions, Methods of concreting-Pumping, under water concreting, shotcrete, High volume fly ash concrete concept, properties, typical mix, Self compacting concrete concept, materials, tests, properties, application and Typical mix.

### UNIT - 5



Fiber reinforced concrete - Fibers types and properties, Behavior of FRC in compression, tension including pre-cracking stage and post-cracking stages, behavior in flexure and shear, Ferro cement - materials, techniques of manufacture, properties and application. Light weight concrete-materials properties and types. Typical light weight concrete mix High density concrete and high performance concrete-materials, properties and applications, typical mix.

## REFERENCES

1. Neville, A.M. and Brooks, J.J., " CONCRETE TECHNOLOGY", ELBS .1990.
2. Neville, A.M., "PROPERTIES OF CONCRETE", PITMAN. 1983.
3. Brandt, A.M., "CEMENT BASED COMPOSITES: Materials, Mechanical Properties and Performance", E & FN Spon. 1995.
4. Newman, K., "CONCRETE SYSTEMS in COMPOSITE MATERIALS".EDT BY L.Holliday. Elsevier Publishing Company. 1966.

## **CE41T15 : ENGINEERING ECONOMICS**

1. Basic economic concepts: Stock and Flow, Static and Dynamic economics, Micro economics and Macroeconomics, National Income concepts.
  2. Market demand : Demand, meaning and types, Law of demand, exceptions to the law of demand, Elasticity of Demand, Methods of measuring elasticity of demand, Marginal utility Analysis.
  3. Production analysis: Production functions, law of returns, least cost combination, cost and cost curves, choice of plant size in the long run.
  4. Supply: Law of supply, elasticity of supply.
  5. Cost concepts and estimation: Cost elements, economic vs. accounting concepts of costs and Revenues, Standard Cost, Actual Cost, Over head Cost, Cost control, Break Even Analysis.
  6. Economic appraisal techniques: Long Range and Short range Budgeting, Criteria for Project Appraisal, Social benefit cost analysis, Depreciation: concepts and Techniques.
  7. Monetary System: Money and its functions, Functions of the Commercial Bank and Central Bank, Monetary Policy.
  8. Inflation and business cycles: Causes, effects and methods to Control Inflation, Concepts of Business Cycles.
  9. Accounting: Book keeping single and double entry system, Journal and ledger, Trading account, Profit and loss account, Balance sheet.
- Books: 1. A Text Book of Economic Theory : Stonier and Hauge.  
2. Modern Economic Theory : K.K.Dewett  
3. Engineering Economics : Degramo.  
4. A Text Book of Economic Theory : Sammuelson.  
5. International Economics : Bo Sodersten  
6. Principles of Macroeconomics : Rangarajan and Dholakia.  
7. Monetary Economics : Suraj B. Gupta

## **CE41T16 : QUALITY CONTROL & ASSURANCE IN CONSTRUCTION**

UNIT 1 CONSTRUCTION PROJECTS : Agencies involved in Construction Projects, mutual relationship, quality control at site; and whose job is it.

Unit 2 ISO / IS Requirements : IS 9000 (Parts 1 to 4) (Pt 1; 1994, Pt 2; 1993, Pt 3; 1991, Pt 4; 1993) for Total Quality Management. ISO 14000 – 1988 for environment – Impact of large construction projects.

Unit 3 Quality Control on Construction Projects : Inspection of reinforced concrete, masonry and steel works, testing techniques and quality at reports.

Unit 4 Statistical Analysis : Sampling frequencies, statistical and reliability analysis, optimum sample size.

Unit 5 Quality Assurance : Quality Assurance in constructions

Name of Text Books:

ISO 9000 in Construction – Nee, Paul A. (Wiley Interscience Publication, 1994)

IS: 14000, – Quality System – Guidelines for Selection and Use of Standards on Quality System 1988.

**Name of Reference Books:**

ISO 9000 in Construction – Wah, L.S., Min., L.C. & Ann, T.W. (McGraw Hill Book Company, 199 Construction Engineering and Management – S. Seetaraman (Umesh Publication)

## **CE41T17 : MANAGEMENT INFORMATION SYSTEM**

**Unit I:** Management and System- Advance in management, the process of MIS development, MIAS organization, Information dynamics.

**Unit II:** Planning, Design and implementation of MIS, Strategic planning, MIS design- Group design concepts, Acquiring information system.

**Unit III:** System life cycle-Information flow, Entity relationship modeling, data modeling, detailed process analysis, data flow diagrams.

**Unit IV:** Decision making system with MIS, System concepts for MIS.

**Unit V:** Data information and communication, problem solving and decision making, security, control and failure, Future trends in MIS.

**Name of Text Books:**

Management Information Systems, by S. Sadagopan, PHI Learning Pvt. Ltd

Management Information Systems By . Chatterjee, PHI Learning Pvt. Ltd

Management Information Systems (11th Edition), by Ken Laudon and Jane Laudon

## **CE41T18 : VALUE ENGINEERING**

### UNIT – I Basic Concepts

Meaning of the term value, basic kind, reasons for poor value, value addition, origin and history. Benefits, relevance in Indian scenario.

### UNIT – II Techniques

Different techniques, organizing value engineering study, value engineering and quality.

### UNIT – III Job Plan

Different phases, General phase, Information phase, Functional Phase, Creation Phase, Evaluation Phase, Investigation Phase, Implementation Phase, Audit.

### UNIT – IV Selection of evaluation of VE Projects

Project selection, method selection, value standard, application of methodology.

### UNIT – V Value Engineering Program

VE operations in maintenance and repair activities, VE Cost, life cycle, cost model, training for VE, general value engineering, case studies.

### TEXT BOOKS

Value Engineering – S.S. Iyer – New Age International Publishers, New Delhi

Industrial Engineering & Management – O.P. Khanna – Dhanpat Rai & Sons

### REFERENCES

Techniques of Value Analysis and Engineering – L.D. Miles – McGraw Hill, New York

Value Engineering, A Systematic Approach – A.E. Mudge – McGraw Hill, New York

Compendium on Value Engineering – H.G. Tufty – Indo American Society

## **CE41T19 : ENTERPRISE RESOURCE PLANNING**

UNIT-1: Conceptual foundation of Business Process reengineering: Role of information Technology and BPR; Process improvement and Process redesign, Process identification and mapping; Role/Activity diagrams, Process Visioning, and benchmarking.

UNIT -2: Enterprise Resource Planning: Evolution of ERP- MRP and MRP II, structure of ERP- two tier architecture, three tier architecture, Electronic data processing, management information system, Executive information system, ERP as an integrator of information needs at various Levels.

UNIT -3 Typical Business Processes: Core processes, Product control, Sales order processing, Purchases, Administrative processes, Human resource, Finance support processes, Marketing, Strategic planning, Research and development, Problems in traditional view.

UNIT -4: ERP models/functionality: Sales order processing, Production scheduling, forecasting, distribution, finance, features of each of the models, description of data flow across each module, overview of supporting databases & packages.

UNIT -5: ERP implementation issues: Opportunities and problems in ERP selection, and implementation; ERP implementation: identifying ERP benefits, team formation, Consultant intervention, Selection of ERP, Process of ERP.

**Books:** 1 .V.K. GARG & N .K. VENKATKRISHNAN:, ERP, Concepts and Practices, PM  
2 Rahul V. Altekar, Enterprise wide Resource Planning-theory and practice, PHI

**References:** 1. ALEXIS LEON: Enterprise Resource Planning, TMH S. SADAGOPAN: MIS, PMV. RAJARAMAN: Analysis and Design of Information Systems, PHIMONK' & BRADY: Concepts in ERP, Vikas pub, Thomson

## **CE41T20 : FINANCE MANAGEMENT**

UNIT I Financial Management –an overview: Introduction, finance and other disciplines, objectives and scope of financial management, role and responsibility of finance manager.

UNIT II: Working capital management-nature, need, importance and concept of working capital, trade off between profitability and risk, Determining finance mix.

UNIT III: Inventory management-Introduction, objectives, ordering cost, carrying cost, lead time, economic order quantity and safety stock, deterministic model.

UNIT IV: Management of cash-introduction motives for holding cash, objectives of cash management and technique/process of cash management.

UNIT V: Receivables management-introduction, objectives, credit terms, credit policies and collection policies.

**Text books:** Basic financial management, M Y Khan and P K Jain, TMH  
Financial Management, I M Pandey.

**References books:** Financial management and policy, V K Bhalla, Anmol publications pvt. Ltd.

Financial management, Van Horne.

## **CE41T21 : SAFETY IN CONSTRUCTION**

Unit 1 Construction Project :A brief outline project definition, elements, relation to safety, types of projects and safety hazards.

Unit 2: Construction sites and safety :Tools – Electrical, Pneumatic, Grinding, Hand tools. Machinery – Earth moving, Concrete Breaker, Carpenters, Transporting, Batching Plant and Concrete Mixer, Dumpers. Material Handling – Various materials and their effects, storing materials. Common Risks and Hazards.

Unit 3 Planning Safety for Construction Projects: Safety Construction Safety, Legal Requirements, First-Aid, Safety Clauses in contract, Safety Policy, Safety deposit, Safety Officer, Safety Committees, Safety of Contractors Worker.

Unit 4 Safety Practices:Roads and bridges, tunneling, buildings, and structures, (excavation, blasting, consent, machinery, transportation, concrete structures, piling, deep foundations, compressed air, tunneling, dewatering, structural steel erection, floors, and walk opening, demolition, use of ladders, electrical works, welding and cutting, grinding and chipping, hoisting apparatus, A.C. Roofs.

Unit 5 Modern project; Special Safety practices for Modernisation Project Planning for sequential operations and emergencies first aid, fire hazards and preventive methods.

Name of Text Books: Construction Safety, Security and Loss Prevention – B. Fulman.

Name of Reference Books: Fundamental of Construction Safety – P.T. Armstrong.

Construction Engineering and Management – S. Seetaram (Umesh Publication)

## **CE41T22 : CONSTRUCTION MATERIALS & MATERIALS MANAGEMENT**

Unit-1 Materials and their properties required for Modern buildings.

Unit-2 Special construction materials like fly ash, silica fume, FRP, FRC, admixtures SCC, HPC. Soils and Rock materials in different zones, cut off trenches in earth dam.

Unit-3 Mode of transport and receipt of above materials. Testing at site, inspection procedures.

Unit-4 Importance and functions of material management, Classification and Codification of materials, Procurement, identification of sources of procurement, vendor analysis. Application of ABC and EOQ analysis in inventory control.

Unit-5 Use of Indices in materials/inventory models Inventory Management, safety stock, stock outs, stores management, Foreign purchase, Governmental buying.

References

Ghose, Materials of Construction' by, Tata- McGraw Hill Publication.

Gopalkrishnan ,Handbook of Materials management , Prentice Hall Publication.

A.K. Dutta ,Materials Management

Dean S. Ammer, Materials Management and Purchasing, Taraporevala Publications

B.K. Roy Chowdhury , Management of Materials , S. Chand & Sons

A. Deb, Materials Management

Lee and Dobler, Purchasing and Material Management, McGraw Hill Publications

P. Gopalakrishnan and Sundaresan, Materials Management An Integrated Approach , Prentice Hall of India

K.S. Menon Purchasing and Inventory Control, Wheeler Publishing

Magee and Boodman, Production, Planning & Inventory Control

Martin K. Starr and Miller, Inventory Management, Prentice Hall of India Pvt. Ltd.

## SEMESTER VIII

### CE42T01: STRUCTURAL ENGINEERING DESIGN – IV

**Unit-I:** continuous beam and slab systems (one way and two way).

**Unit II:** Combined footings (Rectangular, Trapezoidal and strap footing)

**Unit-III:** Design of Cantilever retaining wall and introduction to counter fort retaining walls

**Unit-IV:** Water tanks-resting on ground

**Unit-V:** Elevated water tanks (Intze Tank)

*Reference book: Design of Reinforced Concrete Structures by P. Dayaratnam*

*Reinforced Concrete Design by S.N .Sinha*

*Reinforced Concrete Design by Pillai & Menon*

*Limit State Design of Reinforced Concrete by P.C. Verghese*

### CE42T02: CONSTRUCTION PLANNING AND MANAGEMENT

			SESSIONAL - TA			ESE
L	T	P	IA	MSE	TOTAL	
3	1	-	20	20	40	60

#### Unit 1

**Introduction :** Objectives and functions of project management, project feasibility reports, Planning for construction projects, Cost control in construction-importance, objectives of cost control, cost control systems.

#### Unit 2

**Scheduling:** Scheduling Job layout and Line of balance, project management through networking, Bar Chart, Linked bar chart, Work-break down structures, Activity-on-arrow diagrams.

CPM: Critical Path, Probabilistic activity durations; Event based network,

PERT Network: Time-cost Study, Crashing, Resources allocation.

**Economics of Project management:** Economic analysis of engineering projects, economic studies, sensitivity analysis, Introduction to Management Information System (MIS)- definition, outline of MIS.

#### Unit 3

**Safety and Quality Control:** Importance, causes of Accidents safety measures, responsibility for safety, safety benefits to various parties.

Quality control in construction: Importance, Elements of quality, Quality Assurance Techniques, Quality Control Circles. Total Quality Management in construction, Introduction, Elements of TQM, Approaches to total quality, difference between traditional management and TQM, Applications and constants of TQM in construction process.

#### Unit 4

**Construction Equipments and Management :** Classification of construction equipments,

Earth moving equipments: Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheet foot rollers, pumps, hauling equipments, hoisting equipments, aggregate and concrete production equipments: Weight batcher, Mixer, Vibrator, Batching Plant, Concrete pump, Cranes, Lifting equipment, pile driving equipments.

## Unit 5

Time and motion studies, waiting line theory, factors affecting selection of construction equipments, cost of owning and operating the construction Equipment, equipment maintenance.

### **Name of Text Books:**

Construction Engineering and Management – S. Seetharaman (Umesh Publications, New delhi, 1997)

PERT & CPM – Punmia, B.C. and Khandelwal, K.K. (Laxmi Publications, New Delhi 1997)

Construction Management and Planning – Sen Gupta & Guha (Tata McGraw Hill)

### **Name of Reference Books:**

Construction Planning Equipment and Methods – Peurify/ Schexnayder, 6th Edition (Tata McGraw Hill)

PERT & CPM – Sreenath, I.S. (East West Press, New Delhi, 1975)

Construction Management and Accounts – Vazirani, V.N. & Chandola, S.P. (Khanna Publishers, New Delhi, 2002)

Construction Planning and Management – Gahlot & Dhir (New Age Publishers)

## **CE42T03 : AIR AND WATER QUALITY MODELLING**

### **1. Modelling/Concept**

Water and air quality management – Role of mathematical models; systems approach – systems and models – kinds of mathematical models – model development and validation effluent and stream standards; ambient air quality standards.

### **2. Surface Water Quality Modelling:**

Historical development of water quality models; rivers and streams water quality modeling – river hydrology and flow – low flow analysis – dispersion and mixing – flow, depth and velocity – estuaries – estuarine transport, net estuarian flow, estuary dispersion coefficient; Lakes and impoundments – Water quality response to inputs; water quality modeling process – model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens; Streeter – Phelps models.

### **3. Air Quality Modelling:**

Transport and dispersion of air pollutants – wind velocity, wind speed and turbulence; estimating concentrations from point sources – the Gaussian Equation – determination of dispersion parameters, atmospheric stability; dispersion instrumentation – Atmospheric traces; concentration variation with averaging time; Air pollution modeling and prediction – Plume rise modeling techniques, modeling for non-reactive pollutants, single source – short term impact, multiple sources and area sources, model performance and utilisation, computer models.

### **4. Groundwater Quality Modelling:**

Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modelling

### **5. Computer Models:**

Exposure to computer models for surface water quality, groundwater quality and air quality.

### **References:**

2. Steven C. Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies, Inc., New York, 1997.

3. R.W. Boubel, D.L. Fox, D.B. Turner & A.C. Stern, Fundamentals of Air Pollution Academic Press, New York, 1994.

4. Ralph A. Wurbs, Water Management Models – A Guide to Software, Prentice Hall. PTR, New Jersey, 1995.

## **CE42T04 : INDUSTRIAL WASTEWATER MANAGEMENT**

### **1. Introduction**

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling - generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management

### **2. Industrial Pollution Prevention**

Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Pollution Prevention of Assessment - Material balance - Evaluation of Pollution prevention options –Cost benefit analysis – pay back period - Waste minimization Circles

### **3. Industrial Wastewater Treatment**

Equalisation - Neutralisation – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors –High Rate reactors - Chemical oxidation – Ozonation – carbon adsorption -Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.- Treatability studies.

### **4. Wastewater Reuse And Residual Management**

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

### **5. Case Studies**

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries.

### **References:**

1. Eckenfelder, W.W., 'Industrial Water Pollution Control', Mc-Graw Hill, 2000.
2. Nelson Leonard Nemerow, "Industrial waste treatment – contemporary practice and vision for the future", Elsevier, Singapore, 2007
3. Frank Woodard, 'Industrial waste treatment Handbook', Butterworth Heinemann, New Delhi, 2001.
4. World Bank Group, 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production', World Bank and UNEP, Washington D.C., 1998
5. Paul L. Bishop, 'Pollution Prevention: - Fundamentals and Practice', Mc-Graw Hill International, Boston, 2000.

## **CE42T05 : AIR POLLUTION CONTROL ENGINEERING**

### **INTRODUCTION:**

Sources and classification of Air pollutants: Natural contaminants, Aerosols, Gases & Vapors; Primary & Secondary Air pollutants; Stationary & Mobile Sources.



Meteorology and Air pollution: Factors influencing Air pollution; Atmospheric stability & temperature inversions; Mixing height; Plume behavior; Wind rose; Stack effluent dispersion theories; Stack height.

**SAMPLING PROCEDURES:** Sampling Methods, Difficulties in sampling, Stages & considerations of air sampling, Instruments for sampling waste gases & atmosphere, sampling period & methods, High volume sampler, Stack sampling techniques, selection of sampling location, procedure for collection & sampling of particulate matter, Gaseous sampling, recent trends in sampling of stack effluents.

Control of Particulates / aerosols: Objectives & types of Collection equipment; Principle, application, working, advantages & disadvantages of: i) Settling chambers, ii) Inertial separators, iii) Cyclones, iv) Filters, v) Electrostatic Precipitators & vi) Scrubbers; Choice of equipment.

Control of Smoke -Gaseous Contaminants & Odour:

Smoke: Sources, measurement by Ringelmann chart, miniature chart & other method; Prevention & control of smoke. Control of exhaust emissions.

Gaseous Contaminants: Methods of control viz combustion, absorption, adsorption, closed collection & masking.

Odour Control.

Control measures for Industrial Applications:

Introduction to control of air pollution by process changes.

Control measures for industries such as Cement Industry, Concrete batching plant, Asphaltic concrete plant, Glass manufacture, Asbestos processing, Thermal Power plant and Coal tar industry.

#### **References:**

1. Richard W. Boubel et al "Fundamentals of Air pollution", Academic Press, New York, 1994.
2. Noel de Nevers, Air Pollution control Engineering, McGraw Hill, New York, 1995.
3. M.N. Rao et al, "Air Pollution" Tata McGraw Hill, 1989.

## **CE42T06 : ENVIRONMENTAL IMPACT ASSESSMENT**

### **1. Introduction**

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Public Participation in EIA. EIA process- screening – scoping - setting – analysis – mitigation

### **2. Components And Methods For Eia**

Matrices – Networks – Checklists – Connections and combinations of processes – Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological — Cumulative Impact Assessment – Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation. EIA methods in other countries.

### **3. Socio-Economic Impact Assessment**

Definition of social impact assessment. Social impact assessment model and the planning process. Rationale and measurement for SIA variables. Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition - neighborhood and community impacts. Selecting, testing and

understanding significant social impacts. Mitigation and enhancement in social assessment. Environmental costing of projects.

#### **4. Environmental Management Plan**

Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment.

#### **5. Sectoral EIA**

EIA related to the following sectors - Infrastructure –construction and housing Mining – Industrial - Thermal Power - River valley and Hydroelectric – coastal projects-Nuclear Power. EIA for coastal projects.

#### **References:**

1. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
2. World Bank –Source book on EIA
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 1999.
4. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York.

## **CE42T07 : SOLID AND HAZARDOUS WASTE MANAGEMENT**

### **1. Municipal Solid Waste Management:**

Legal and Organizational foundation: Definition of solid waste – waste generation technological society – major legislation, monitoring responsibilities, sources and types of solid waste – sampling and characterization – Determination of composition of MSW – storage and handling of solid waste – Future changes in waste composition.

### **2. Collection and Transport of Solid Waste:**

**Collection of Solid Waste:** Type of waste collection systems, analysis of collection system – alternative techniques for collection system. Separation and Processing and Transformation of Solid Waste: unit operations user for separation and processing, Materials Recovery facilities, Waste transformation through combustion and aerobic composting, anaerobic methods for materials recovery and treatment – Energy recovery – Incinerators

**Transfer and Transport:** Need for transfer operation, transport means and methods, transfer station types and design requirements. **Landfills:** Site selection, design and operation, drainage and leachate collection systems – requirements and technical solution, designated waste landfill remediation – Integrated waste management facilities.

### **3. Hazardous Waste Management:**

Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, ewaste - sources, collection, treatment and reuse management.

### **4. Hazardous waste treatment and Design:**

Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.

### **5. Laboratory Practice:**

Sampling and characterization of Solid Wastes; TCLP tests and leachate studies.

**References:**

1. George Tchobanoglous et al, “Integrated Solid Waste Management”, McGraw-Hill Publication, 1993.
2. Charles A. Wentz; “Hazardous Waste Management”, McGraw Hill Publication, 1995.

**CE42T08 : ENVIRONMENTAL GEOTECHNOLOGY****1. Soil- Pollutant Interaction:**

Introduction to geo environmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil-pollutant interaction- Physico-chemical behavior and modelling -failures of foundations due to pollutants

**2. Characterization, Stabilization and Disposal**

Safe disposal of waste – site selection for land fills – characterization of land fill sites – waste characterization –stability of land fills – current practice of waste disposal- passive contaminant system - Hazardous waste control and storage system – mechanism of stabilization - solidification of wastes – micro and macro encapsulation – absorption, adsorption, precipitation- detoxification — organic and inorganic stabilization

**3. Transport of Contaminants:**

Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers.

**4. Detection and Testing Methods**

Methodology- review of current soil testing concepts – Proposed approach for characterization and identification of contaminated ground soil for engineering purposes

**5. Remediation of Contaminated Soils:**

Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – exsitu and insitu remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well- application of geo synthetics in solid waste management – rigid or flexible liners.

**References:**

1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
2. Daniel, B.E., Geotechnical practice for waste disposal, Chapman and Hall, London, 1993.
3. Fang, H.Y. Introduction to environmental Geotechnology, CRC press New York, 1997.
4. Lagrega, M.d., Buckingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.

**CE42T09 : Water Resources Planning & Management****Unit 1****Introduction**

Role of water in national development, assessment of water resources of country, scope of water resources development vis-a-vis environment, Irrigation development in India, utilisation of Irrigation potential.

**Unit 2****Planning**

Water resources planning process; planning for single purpose and multipurpose projects, estimation of different water needs and project formulations, comparison of alternatives, cost-benefit analysis.

### **Unit 3**

#### **Water Resources Systems**

Definition, types of system, optimization techniques, system approach, system analysis, linear programming, formulation of a linear programming problem, formulation with different types of constraints, graphical analysis, graphical solution, simplex method, optimization techniques and systems approach.

### **Unit 4**

#### **Management**

Evaluation and monitoring of water quantity and quality, managing water distribution networks for irrigation, flood control and power generation, inter-basin transfer of water, conjunctive use of surface and ground water.

### **Unit 5**

#### **Modelling**

Water quantity and quality modelling, evaluation of impacts of water resources projects on river regimes and environment, reservoir sedimentation and watershed management.

#### **Name of Text Books:**

Principles of Water Resources Planning – Good Man, A.S., (Prentice Hall, Inc., Englewood Cliffs, N.J. 1984.)

Water Resources Engineering – Linsley, R.K. and Franzini, J.B., (3rd Edition) (McGraw Hill, New York, 1979)

#### **Name of Reference Books:**

Water Resources System, Planning and Management – M.C. Chaturvedy (Tata McGraw Hill)

System Approach to Water Management – Biswas A.K. (Tata McGraw Hill)

Water Resources System, Planning and Management – Helweg O.J. (John and Wiley & Sons)

## **CE42T10 : Ground Water Hydrology**

Hydrologic cycle, Water balance, Occurrence of ground water: Origin, geological formations as aquifers, type of aquifers, groundwater basins, springs. Darcy's Law, validity of Darcy's Law permeability, laboratory and field measurement of permeability, groundwater Flow lines. Steady flow to a well, steady radial flow to a well in confined aquifer and unconfined aquifer, Unsteady radial flow into a confined aquifer, Non equilibrium Theis equation, Theis method of solution, multiple well system; Methods of constructions of deep and shallow wells: The percussion (or cable tool) method of drilling, Direct circulation hydraulic rotary method, Down the hole hammer method, well logs-receptivity logging, testing of wells for yield, Effect of irrigation, stream flow, rainfall on groundwater fluctuations, seasonal and secular variations, fluctuation due to miscellaneous causes; Surface and Subsurface investigations of groundwater: Geophysical exploration, Electrical resistivity method, aerial photo interpretation, remote sensing applications to ground water exploration, test drilling, Artificial recharge by water spreading, through pits and shaft, recharge through other methods; Ground water pollution: Municipal sources, liquid wastes from domestic uses, solid wastes, Industrial sources, tank and pipeline leakage, Mining activity, agricultural sources, septic tank and cesspools, saline water intrusion in coastal aquifers, methods to control saline water intrusion ; Groundwater management: Concepts of Basin management,

Equation of hydrologic equilibrium, groundwater basin investigations, conjunctive use of surface and groundwater.

Essential Reading:

1. K. C. Patra, Hydrology and Water Resources Engg., Narosa Publishing house, New Delhi.
2. D. K. Todd, Groundwater Hydrology, John Wiley and Sons.

Supplementary Reading:

1. H. M. Raghunath, Ground Water.
2. S. P. Garg, Groundwater and Tube Wells, Oxford and IBH Publishing Co., New Delhi.
3. V. T. Chow, Hand book of Applied Hydrology, McGraw-Hill Publishing Company, New York.

## **CE42T11 : ADVANCE FLUID MECHANICS**

Dynamic of Fluid Flow, One-Dimensional method, The Navier Stokes Equation, Limiting Case, Applications. Boundary Layer Theory for low and high Viscosity, Boundary Layer thickness, Prandtl's Equation, Momentum Integral Equation, Pressure Distribution in boundary layer. Dimension analysis and similarities, Buckingham theorem, types of similarities, forces influencing hydraulic phenomenon, significance of dimensionless numbers, distorted model, and model proto type similarity law; Laminar and Turbulent Flow in Pipes, Reynolds experiment, mechanism of turbulent flow, Prandtl's mixing length theory, Karmans similarity hypothesis, Universal velocity distribution near solid boundary, Hydro dynamically smooth and rough pipes. Power law for velocity distribution, Nikuradse experiment, Ageing of Pipes; Compressible Fluid Flow, Equation of motion, continuity equation and energy equation. Stagnation point and its properties, flow through ducts of varying areas, flow through convergent and divergent nozzles, effects of compressibility, shock waves, supersonic expansion and contraction; Ideal Fluid Flow, Circulation and Vorticity, Source and sink, combining flow field by super position, combined flow field for Engineering importance. Doublet in rectilinear flow and Doublet with Circulation. Flow past a cylinder curved flow and with circulation and their different combinations; Unsteady flow in bounded systems, Quasi-steady flow, unsteady flow in pipes and open channel flow. Finite difference representation of depth dependent-discharge, Simulation of unsteady flow in pipes, channels and ducts. Development of St. Venant equation of continuity and motion Non uniform flow in open channel flow, equation of gradually varied flow. Classification of water surface profiles, location of hydraulic jump.

**Essential Reading:**

1. J. F. Douglas, J. M. Gasiorek, J. A. Swaffield, *Fluid Mechanics*, Pearson Education.
2. R. J. Garde, A. G. Mirajgaoker, *Engineering Fluid Mechanics*, SciTech Publication, Chennai.

**Supplementary Reading:**

1. V. L. Streeter, Fluid Mechanics, McGraw-Hill Book, New York, 1971.
2. J. A. Liggett and D. A. Caughey, Fluid Mechanics: An interactive text, ASCE press.
3. A. K. Jain, Fluid Mechanics, Khanna Publishers, Delhi.
4. K. C. Patra, Engineering Fluid Mechanics and Hydraulic Machines, Narosa publishing house, New Delhi.

5. Fluid Mechanics and Application with CD roams, CENGEL, Prentice Hall, New Delhi.

## **CE42T12 : RAINWATER HARVESTING**

Over-exploitation of groundwater - Need for artificial recharge and rainwater harvesting - types of wells - drilling technology - design, construction and development of water wells: dugwells and borewells; direct and reverse rotary drilling; cable tool and DTH hammer drilling; gravel packing and well development procedures.

Types of pumps - various artificial recharge structures: recharge ponds - recharge pits - percolation ponds - basin spreading - surface and subsurface dykes - recharge wells - recharge borewells. Rainwater harvesting in urban areas : RWH structures - design - construction.

Estimation of probable runoff from an area including from roof tops - maintenance and monitoring of RWH structures. Study of benefits - effects on local groundwater environments - remedial measures. Recycling of domestic water - sources of water for recharge in urban areas.

Precautions for source, construction and establishing RWH structures. Exploration techniques and selection of artificial recharge zones - electrical resistivity investigations using horizontal profiling and vertical sounding techniques: interpretation of resistivity data in terms of subsurface geology.

Books:

1. Groundwater Hydrology, David Keith Todd, 2nd edition, 1976, John Wiley and Sons, New York.
2. Groundwater, S.Ramakrishnan, 1998, Published by the Author, Chennai 600 041, India.
3. Holmes' Principles of Physical Geology, Duff, 4th Edition, 1993, Chapman and Hall India, Chennai 600 035.
4. Textbook of Engineering Geology and General Geology, Parbin Singh, 6th Edn, 2003, S.K.Kataria and Sons, Delhi 110 051, India.
5. Groundwater and Tube Wells, S.P.Garg, 2nd Edition, 1987, Mohan Pramlani for Oxford and IBH Publishing Co.Pvt Ltd, New Delhi 110001.
6. Groundwater, S.Sankara Pitchaiah, 1995, Scientific Publishers, Jodhpur 342 001, India.
7. Water Resource Systems - Hydrological risk, Management and Development, Edited by Guenter Blosch, Stewart Franks, Michio Kamagai, Katumi Musiaka and Dan Rosbjerg. Proceedings of an international symposium held during IUGC 2003, the XXIII General Assembly of the International Union of Geodesy and Geophysics at Sapporo, Japan.
8. Water Management in Urban Areas, 2003, Proceedings of Training of Trainers, Central Groundwater Board, Chennai, India.
9. Rainwater Harvesting Techniques to augment Groundwater, 2003. Ministry of Water Resources, Central Groundwater Board, Faridabad, India.
10. Water Resource and Water Quality Management for Sustainable Drinking Water Supply, proceedings published by the Tamil Nadu Water and Drainage Board, Chennai, India 2001.

## **CE42T13 : ADVANCE TRANSPORTATION ENGG.**

### **Unit 1**

Rail transport, Railway surveying, Rolling stock and track resistance, Permanent way, Railway gauges, Sleepers, Ballast and Track design.

### **Unit 2**

Track maintenance, Station and yards, Points and crossings, Signaling, Tractive power and tractive resistance.

### **Unit 3**

Introduction, Highway Surveys and plans, Highway alignment, Road Drainage, Road geometrics.

### **Unit 4**

Traffic engineering, Road materials: Soil, Aggregate, Binders: Bitumen. Road Pavement, Soil stabilization, Design factor, Design of flexible pavements, Design of rigid pavements.

### **Unit 5**

Road Maintenance: General causes, Failure of flexible pavements, typical flexible pavement failures, Failure in cement concrete pavements, typical failure of rigid pavements, maintenance of bituminous roads, formation of waves and corrugations in flexible pavements, remedial measures for waves and corrugations.

Tunnels: Advantages and disadvantages, Economics, Selection of routes, classification. Tunnel surveying, methods of tunnelling in soft strata, compressed air methods, tunneling in rock, safety precaution, tunnel lining, tunnel drainage, tunnel ventilation.

### **Name of Text Books:**

S. Chandra & M. M. Agarwal, *Railway Engineering*, Oxford University Press, New Delhi, 1st Ed. 2007.

R. Srinivasan, *Harbour Dock and Tunnel Engineering*, Charotar Publishing House, 20th Ed. 2006.

Traffic Engineering and Transport Planning – Kadiyali, L.R. (Khanna Publishers, Delhi, 1996)

Transport Planning and Traffic Engineering – Flaherty, CAO (John Wiley & Sons, Inc., New York, 1997)

Traffic Engineering – McShane, W.R. and Roes, R.P. (Prentice Hall, New Jersey, 1990)

### **Name of Reference Books:**

Principles of Urban Transport Systems Planning – Hutchinson, B.G. (Scripta Book Company, Washington, D.C., 1974)

Modelling Transport – Ortuzar, title D. and Willumson, L.G. (John Wiley & Sons, New York, 1995)

M. M. Agrawal, *Railway Engineering*, Standard Publishers New Delhi, 2002.

S. C. Saxena & S. P. Arora, *A text Book of Railway Engineering*, Dhanpat Rai & Sons.

S. C. Saxena, *Tunnel Engineering*, Dhanpat Rai & Sons, 2006.

Transport Planning and Traffic Engineering – Flaherty, CAO'(Ed.) (John Wiley & Sons, Inc., New York, 1997)

Traffic Flow Fundamentals – May, A.D. (Prentice Hall, Englewood Cliffs, New Jersey, 1990)

## **CE42T14:GROUND IMPROVEMENT TECHNIQUES**

Introduction: Engineering properties of soft, weak and compressible deposits, Natural on land, off-shore and Man-made deposits. Role of ground improvement in foundation engineering, methods of ground improvement, Selection of suitable ground improvement techniques ; In-situ methods: In-situ densification soils, Dynamic compaction and consolidation, Vibrofloatation ,Sand pile compaction, Preloading with sand drains and fabric drains, Granular columns, Micro piles, Soil nailing, Ground Anchors, Lime piles, Injections, Thermal, Electrical and Chemical methods, Electro osmosis, Soil freezing ; Reinforced Soil: The Mechanism, Reinforcement materials, Reinforcement - Soil Interactions, Geosynthetics, Principles, Analysis and Design of Reinforced Retaining Structures, Embankments and Slopes, soil nailing.

Essential Reading:

1. R. M. Korner, Design with Geosynthetics, Prentice Hall, New Jersey, 3rd Edn. 2002.
2. P. P. Raj, Ground Improvement Techniques, Tata McGraw Hill, New Delhi, 1995.

Supplementary Reading:

1. B. M. Das, Principles of Foundation Engineering Thomson, Indian Edition, 2003.
2. G. V. Rao & G. V. S. Rao, Text Book on Engineering with Geotextiles, Tata McGraw Hill

Hill

3. T. S. Ingold & K. S. Miller, Geotextile Hand Book, Thomas Telford, London.
5. N. V. Nayak, Foundation Design Manual, Dhanpat Rai and Sons, Delhi.



## **CE42T15:DYNAMICS OF SOIL & FOUNDATION**

Vibration of elementary systems, Analysis of systems with Single degree and multi-degree of freedom. Natural frequencies of continuous systems; Elastic Constants of soil and their experimental determination. Effect of vibration on soil properties; Bearing capacity of dynamically loaded foundations. ; Principles of Machine foundation design, Experimental and analytical determination of design parameters. ; Design of foundations for turbines, vertical and horizontal reciprocating engines; forge hammers, Effect of machine foundation on adjoining structures, vibration isolation.

Essential Readings:

1. S. Saran, Soil Dynamics and Machine Foundations, Galgotia Publications Private Ltd.1999.
2. N. S. V. K. Rao, Vibration Analysis and Foundation Dynamics, Wiley New Delhi, 1998.

Supplementary Readings:

1. B. M. Das, Principles of Soil Dynamics, Thomsons Engineering, 1992.
2. K. G. Bhatia, Foundations For Industrial Machines, D-CAD Publishers, 2008.
3. A. Major, Vibration analysis and design of foundations for machines and turbines: Dynamical problems in civil engineering, Akademiai Kiado Budapest Collets Holding Ltd., 1962.

## **CE42T16:GEO-INFORMATICS & GIS APPLICATIONS**

Unit-1

Introduction to Data base systems - Data base system levels of abstraction in DBMS principles of data base. Model of real world. Introduction to data organization, information management system preliminary study of INGRES, ORACLE, RDBMS and DBASE.

Introduction to Geographical Information Systems: Introduction maps and spatial information. Computer assisted mapping and map analysis. Geographic Information Systems. The components of geographical Information System. Future directions and trends in GIS.

Unit-2

Data structures for Thematic maps. Data structures for Geographic Information Systems. Points, lines and areas. Definition of a map Geographic data in the computer. File and data processing, data base structures, perceived structures and computer representation and geographical data. Raster data structure, Vector data structures for geographical entities. Data structures for thematic maps - The choice between raster and vector.

Digital Elevation Models: The need of DEMs, methods of representing DEMs. Image methods, data sources and sampling methods for DEMs. Products that can be derived from a DEM. Automated landform delineation from DEMs. Map projections in GIS

Unit-3

Unit-4

Data Quality, Errors and Natural Variation: Sources of error, Errors resulting from natural variation of from original measurements. Errors arising through processing, problem; and errors arising from overlay and boundary intersections. Errors resulting from rasterizing a vector map. Errors associated with overlaying two or more polygon networks. The nature of boundaries. The statistical nature of boundaries. Combining attributes from overlaid maps.

Classification methods: Classification, Multivariate analysis and classification, allocating individuals to existing classes. Expert systems for Geographical Information Systems. Classification methods in geographical information systems.

#### Unit-5

Methods of Spatial interpolation. The available methods for interpolation, global methods of interpolation, location interpolators, optimal interpolation methods using spatial auto covariance. Extensions of cridding to large areas. Comparing cridding with other interpolation techniques. Choosing a Geographic Information System. Designing the needs for GIS. The procedure to following when setting up a geographical information system.

Tools for Map analysis: Single maps, Map reclassification, operations and attribute tables, spatial topological and geometric modeling and operations on spatial Neighborhood. Tools for map Analysis: Map pairs, map overlay and map modeling correlation between two maps. Tools for map analysis: Multiple maps, types of models, Boolean logic models, Index overlay models, Fuzzy logic methods.

#### List of Text books

Principles of Geographical Information System for Land Resource Assessment, P.A. Burrough, Clarendon Press, Oxford, 1986.

Geographic Information Systems, T.R. Smith & Piqent, London Press, 1985.

Principles of data base systems, J.D. Ullman, Computer Science Press.

## **CE42T17: ROCK MECHANICS**

### **UNIT - 1**

**INTRODUCTION TO ROCK MECHANICS:** Definition, Scope and importance, development, application in mining, Discontinuities; Description of discontinuities, Introduction to mapping and hemispherical projection of discontinuities, Barton's shear strength of joints.

**ANALYSIS OF STRESS:** Introduction, Definition and basic concepts, stress in a plane, (two dimensional stress), Mohr's Circle of stress, Secondary principal stress, equations of equilibrium, plane stress equations.

### **UNIT – 2**

**ANALYSIS OF STRAIN:** Introduction, Definition and basic concepts, strain in a plane, (two dimensional stress), Mohr's Circle of strain, equations of compatibility, stress-strain relationship, basic equations in elastic theory, plain strain equations, elasto plastic behaviour of rocks. Stress – strain curves of various rocks.

**PHYSICAL PROPERTIES:** Definition and determination of Density, hardness, porosity, permeability, moisture content, degree of saturation. Electrical and thermal properties of rocks.

### **UNIT - 3**

**MECHANICAL PROPERTIES:** Definition and determination of Compressive Strength, tensile strength, shear strength, triaxial testing. Time dependent properties. Scaling of laboratory data to in-situ values. Rock Indices: protodyakanov strength index, point load strength index, RQD.

**IN-SITU STRENGTH PROPERTIES OF ROCKS:** Necessity and requirement, methods of in-situ stress measurements. Plate load test, cable jack test, bore hole test, dilatometer test, flatjack test, hydraulic fracture and velocity propagation.

### **UNIT - 4**

RHEOLOGICAL MODELS: Relationship and rate of change of stress-strain for idealizing materials – Models representing elastic, plastic, viscous, elasto plastic, non-elastic and brittle rock properties.

UNIT - 5

STATIC AND DYNAMIC ELASTIC CONSTANTS OF ROCKS: Static: Introduction, definition, instrument, measurement of deformation: mechanical, optical, electrical gauges, LVDT, calculation of elastic constants of rocks. Dynamic: Introduction, elastic wave, calculation of modulus of elasticity.

TEXT BOOKS:

Strata Mechanics in Coal Mining - Jeremic, K. L. Jeremic, Rotterdam, Balkema, 1985.

Fundamentals of Rock Mechanics - Jager & Cook, Methuen andco. London, 1969.

REFERENCE BOOKS:

Continuum Theory of rock Mechanics - Csaba Asszonyi, Transtech Publications, 1979.

Hand Book on Mechanical Properties of rocks - R.D. Lama, V. S. Vutukuri, Vol. I to IV, Transtech Publications, 1978.

Mechanics and Engineering - Charles Jaeger, Cambridge University Press, 1979.

Rock Mechanics for Underground Mining - 2nd edition, Brady and Brown, Kluwer Academic Publishers, 1993.

Ground Mechanics in Hard rock Mining - M. L. Jeremic, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.

Rock Mechanics and Design of Structures in Rock - L. Obert & W.I. Duvall, John wiley and Sons, 1966.

Rock Mechanics for Engineers - B. P. Verma, 2nd edition, Khanna Publishers, 1989.

Introduction to Rock Mechanics - R. E. Goodman, 2nd edition, John wiley and Sons, 1989.

The elements of Mechanics of Mining Ground - B. S. Verma Vol. I. Julin & Co. Lucknow 1981.

Engineering Rock Mechanics, An Introduction to the Principles - John A. Hudson and John. P. Harrison Pergamon Press 1997.

## **CE42T18: PLANING & DESIGN OF BUILDING SERVICES**

Integrated design: factors affecting selection of services/systems. Provision of space in the building to accommodate building services. Structural integrity of building services equipment. Sound and vibration attenuation features. Provisions for safe operation and maintenance. Building services engineering system for intelligent buildings: introduction to information transmission systems, communication and protection system, call systems, public address system and Building automation/management systems. The concepts and importance of energy conservation and energy efficiency for environmental protection, environmental protection and maintenance of building services systems, selection of environmentally friendly products and materials used in building services systems. Co-ordination and management of design and installation of various building services systems during the design and construction stages in particular the builder's works. Computer-aided design and installations of building services. Testing and commissioning of building services systems: fire safety systems, vertical transportation equipment ventilation systems, etc. Sick building syndrome. The impacts of life-cycle-cost on planning and implementation. An appreciation of capital and operating costs.

Implication of low cost inefficient equipment, poor installation, inadequate access for maintenance.

### **Text Books**

Stein B. Reynolds J.S. & McGuinness W.J. (1986) Mechanical and Electrical Equipment for Buildings, 7th

Edition, Volume 1 & 2, John Wiley & Sons

Chadderton D.V. (1991) Building Services Engineering, E. & F.N. Spon

Hassan G. (1996) Building Services, Macmillan

Greeno R. (1996) Building Services and Design, Longman

## **CE42T19: DISASTER MITIGATION & MANAGEMENT**

Cyclones: Formation, Cyclonic precipitation, anti-cyclones, Flood: Flood and its estimation, Flood warning, Flood protection measures. Earthquake: Causes of earthquake, plate tectonics, seismic zoning map, Characteristics of strong ground motions & attenuation, damage assessment, rehabilitation and retrofitting of structures. Environmental disaster: Impact assessment studies, computation and preparedness. Disaster management: Developing appropriate technology for disaster mitigation, Role of management teams, importance of awareness, alertness and preparedness camp.

Essential Reading:

1. K. C. Patra, Hydrology and Water Resources Engineering, CRC Press, Florida, USA, 2nd Edition.
2. N. Sharma, Earthquake resistant building construction, S. K. Kataria & Sons, New Delhi.

Supplementary Reading:

1. K. Subramanian, Engineering Hydrology, Tata McGraw Hill, New Delhi.
2. V. P. Singh, Elementary Hydrology, Prentice Hall of India.
3. P. C. Sinha, Disaster Mitigation, Preparedness, Recovery and Response, SBS Publishers & Distributors Pvt. Ltd.
4. D. P. Coppola, Introduction to International Disaster Management, Butterworth-Heinemann.
5. F. B. Friedman, Practical Guide to Environmental Management, McGraw Hill.