



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
(Established by Andhra Pradesh Act No.30 of 2008)  
Kukatpally, Hyderabad – 500 085, Andhra Pradesh (India)

**B.TECH. CIVIL ENGINEERING**

**IV YEAR I SEMESTER**

Code	Subject	L	T/P/D	C
	Remote Sensing & GIS	4	-	4
	Transportation Engineering -II	4	-	4
	Estimating & Costing	4	-	4
	Water Resources Engineering-II	4	-	4
	<b>Elective-II</b>	4	-	4
	Finite Element Methods			
	Advanced Foundation Engineering			
	Watershed Management			
	Air Pollution and Control			
	<b>Elective-III</b>	4	-	4
	Advanced Structural Design			
	Earth and Rock fill Dams and Slope Stability			
	Water Resources Systems Analysis			
	Industrial Waste Water Treatment			
	Concrete & Highway Materials Lab	-	3	2
	Environmental Engineering Lab	-	3	2
	<b>Total</b>	<b>24</b>	<b>6</b>	<b>28</b>

**Note:**All End Examinations (Theory and Practical) are of three hours duration.

**T-Tutorial      L – Theory      P – Practical/Drawing      C – Credits**

L	T/P/D	C
4	-/-	4

(A70140) REMOTE SENSING & GIS

UNIT – I

**Introduction to Photogrammetry:** Principles & types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducial points, parallax measurement using fiducial line.

UNIT – II

**Remote Sensing –:** Basic concept of Remote sensing, Data and Information, Remote sensing data Collection, Remote sensing advantages & Limitations, Remote Sensing process.

Electro-magnetic Spectrum, Energy interactions with atmosphere and with earth surface features (soil, water, vegetation), Indian Satellites and Sensors characteristics, Resolution, Map and Image and False color composite, introduction to digital data, elements of visual interpretation techniques.

UNIT – III

**Geographic Information Systems:** Introduction to GIS; Components of a GIS; Geospatial Data: Spatial Data-Attribute data – Joining Spatial and Attribute data; GIS Operations: Spatial Data Input- Attribute data Management –Data display- Data Exploration- Data Analysis. COORDINATE SYSTEMS: Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters-Commonly used Map Projections - Projected coordinate Systems

UNIT –IV

**Vector Data Model:** Representation of simple features- Topology and its importance; coverage and its data structure, Shape file; Data models for composite features Object Based Vector Data Model; Classes and their Relationship; The geobase data model; Geometric representation of Spatial Feature and data structure, Topology rules

UNIT –V

**Raster Data Model:** Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data Conversion, Integration of Raster and Vector data.

**Data Input:** Metadata, Conversion of Existing data, Creating new data; Remote Sensing data, Field data, Text data, Digitizing, Scanning, on screen digitizing, importance of source map, Data Editing

TEXT BOOKS:

- 1 Remote sensing of the environment – An earth resource perspective – 2nd edition – by John R. Jensen, Pearson Education.
- 2 Introduction to Geographic Information System – Kang-Tsung Chang, Tata McGraw-Hill Education Private Limited.

REFERENCES:

1. Concepts & Techniques of GIS by C.P.Lo Albert, K.W. Yonng, Prentice Hall (India) Publications.
2. Remote Sensing and Geographical Information systems by M.Anji Reddy JNTU Hyderabad 2001, B.S.Publications.
3. Principals of Geo physical Information Systems – Peter A Burragh and Rachael A. Mc Donnell, Oxford Publishers 2004.
4. Basics of Remote sensing & GIS by S.Kumar, Laxmi Publications.

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IV Year B.Tech. CE-I Sem

L	T/P/D	C
4	-/-/-	4

**(A70143) TRANSPORTATION ENGINEERING - II****UNIT – I**

**Introduction to Railway :** Permanent way components – Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast, Gauge –Creep of Rails- Theories related to Creep – Sleeper density.

**UNIT – II**

**Geometric Design of Railway Track:** Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve, Points and Crossing, Rail Joints & Welding of Joints, Railway station& Yards, Signalizing & interlocking.

**UNIT – III**

**Airport Engineering:** Airport Site selection – Runway Orientation – Basic Runway Length – Corrections for Elevation, Temperature – Airport Classification - Runway Geometric design – Factors Controlling Taxiway Layout - Terminal Area – Apron – Hangar – Blast Considerations, Typical Airport Layouts – Wind rose diagram - Runway Lightening system & Marking.

**UNIT – IV**

**Port and Harbour Engineering:** Requirements of Port and Harbour, Classification of Port & Harbour, Features of a Harbour, Planning of Harbour, Breakwaters, Dry docks, Jetties, Aprons, Transit shed and Warehouses, Navigational aids, Maintenance of Port and Harbours, Inland Water Transport

**UNIT – V**

**Intelligent Transport Systems:** ITS Definition, Benefits of ITS, user services, Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Introduction to ITS applications; Advanced Traffic Management systems (ATMS), Advanced Public Transportation systems (APTS), ITS architecture components and standards, Overview of ITS implementations in developed countries.

**TEXT BOOKS:**

1. Satish Chandra and Agarwal, M.M. (2007) "Railway Engineering" Oxford Higher Education, University Press New Delhi.
2. Airport Planning and Design- S.K. Khanna and M.G Arora, Nemchand Bros.
3. A Text book of Transportation Engineering – S.P.Chandola – S.Chand & Co. Ltd. – (2001).

4. Transportation Engineering and Planning – C.S. Papacostas, P.D.Prevedouros.

**REFERENCES:**

1. A Text Book of Railway Engineering-S.C.Saxena and S.Arora, Dhanpatrai and Sons, New Delhi.
2. Highway, railway, Airport and Harbour Engineering – K.P. Subramanian.
3. Harbour, Dock and Tunnel Engineering – R. Srinivasan.
4. Dock and Harbour Engineering – Hasmukh P Oza, Gutam H Oza.

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**(A70138) ESTIMATING AND COSTING**

**UNIT – I**

General items of work in Building – Standard Units Principles of working out quantities for detailed and abstract estimates – Approximate method of Estimating. Detailed Estimates of Buildings.

**UNIT – II**

Earthwork for roads and canals.

**UNIT - III**

Rate Analysis – Working out data for various items of work over head and contingent charges.

**UNIT -IV**

Reinforcement bar bending and bar requirement schedules. Contracts – Types of contracts – Contract Documents – Conditions of contract.

**UNIT – V**

Valuation of buildings. Standard specifications for different items of building construction.

**TEXT BOOKS**

1. Estimating and Costing by B.N. Dutta, UBS publishers, 2000.
2. Estimating and Costing by G.S. Birdie.

**REFERENCES :**

1. Standard Schedule of rates and standard data book by public works department.
2. I. S. 1200 ( Parts I to XXV – 1974/ method of measurement of building and Civil Engineering works – B.I.S.).
3. Estimation, Costing and Specifications by M. Chakraborti; Laxmi publications.
4. National Building Code.

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**(A70133) WATER RESOURCES ENGINEERING-II**

**UNIT-I**

Storage Works-Reservoirs - Types of reservoirs, selection of site for reservoir, zones of storage of a reservoir, reservoir yield, estimation of capacity of reservoir using mass curve- Reservoir Sedimentation – Life of Reservoir.. Types of dams, factors affecting selection of type of dam, factors governing selection of site for a dam.

**UNIT-II**

Gravity dams: Forces acting on a gravity dam, causes of failure of a gravity dam, elementary profile and practical profile of a gravity dam, limiting height of a low gravity dam, Factors of Safety - Stability Analysis, Foundation for a Gravity Dam, drainage and inspection galleries.

**UNIT-III**

Earth dams: types of Earth dams, causes of failure of earth dam, criteria for safe design of earth dam, seepage through earth dam-graphical method, measures for control of seepage.

Spillways: types of spillways, Design principles of Ogee spillways - Spillway gates. Energy Dissipaters and Stilling Basins Significance of Jump Height Curve and Tail Water Rating Curve - USBR and Indian types of Stilling Basins.

**UNIT-IV**

Diversion Head works: Types of Diversion head works- weirs and barrages, layout of diversion head work - components. Causes and failure of Weirs and Barrages on permeable foundations,-Silt Ejectors and Silt Excluders Weirs on Permeable Foundations – Creep Theories - Bligh's, Lane's and Khosla's theories, Determination of uplift pressure- Various Correction Factors – Design principles of weirs on permeable foundations using Creep theories - exit gradient, U/s and D/s Sheet Piles - Launching Apron.

**UNIT-V**

Canal Falls - types of falls and their location, Design principles of Notch Fall and Sarada type Fall.

Canal regulation works, design principles of distributory and head regulators, Cross Regulators -canal outlets, types of canal modules,

Cross Drainage works: types, selection of site, Design principles of aqueduct, siphon aqueduct and super passage.

**TEXT BOOKS:**

1. Irrigation engineering and hydraulic structures by S.K Garg, Khanna publishers.
2. Irrigation and water power engineering by Punmia & Lal, Laxmi publications pvt. Ltd., New Delhi.

**REFERENCES:**

1. Irrigation and water resources engineering by G.L. Asawa, New Age International Publishers.
2. Theory and Design of Hydraulic structures by Varshney, Gupta & Gupta.
3. Irrigation engineering by K.R.Arora.
4. Irrigation Engineering by R.K. Sharma and T.K. Sharma, S. Chand Publishers.
5. Introduction to hydrology by Warren Viessvann, Jr, Garyl. Lewis, PHI.
6. Engineering Hydrology by CS Pojha, R. Berndtsson and P. Bhunya, Oxford University Press.

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**(A70330) FINITE ELEMENT METHODS****(Elective-II)****UNIT – I**

Introduction to Finite Element Method – Basic Equations in Elasticity – stress strain equations – concept of plane stress – plane strain— advantages and disadvantages of FEM.

Element shapes – nodes – nodal degree of freedom – strain displacement relations.

**UNIT – II**

Finite Element Analysis (FEA) of – one dimensional problems – Bar element – Shape functions stiffness matrix

FEA Beam elements – stress strain relation- shape functions -stiffness matrix- continuous beams.

**UNIT – III**

FEA Two dimensional problem – CST – LST element – shape function – stress – strain.

Lagrangian – Serendipity elements – Hermite polynomials – regular, Irregular 2 D & 3D – Element –shape functions.

**UNIT – IV**

Isoparametric formulation – Concepts of isoparametric elements for 2D analysis -formulation of CST element, 4 –noded and 8-noded iso-parametric quadrilateral elements.

**UNIT-V**

Solution Techniques: Numerical Integration, Static condensation, assembly of elements and solution techniques for static loads.

**TEXT BOOKS:**

1. Introduction to Finite elements in engineering by Chandrupatla, Belegundu, Prentice Hall.
2. Finite element method by Daryl L. Logan, CENGAGE Learning.

**REFERENCES:**

1. Finite element analysis by S.S. Bhavikatti-New age International publishers.
2. Finite element analysis by P. Seshu, PHI.

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**(A70134) ADVANCED FOUNDATION ENGINEERING**

**(Elective-II)**

**UNIT – I**

Introduction-Bearing capacity of Footings subjected to Eccentric and inclined loading – Meyerhoff's, Hansen's, Vesic theories – Foundations on layered soils - Elastic settlement of Footings embedded in sands and clays of Infinite thickness – Footings on soils of Finite thickness-Schmertamaunn's method, Janbu method.

**UNIT – II**

Pile Foundations – pile groups- settlement of pile groups resting in sands and clays - negative skin friction-under reamed piles-laterally loaded piles – ultimate lateral capacity - Broms Method - Reese and Matlock Approach.

**UNIT – III**

Lateral earth pressures theories – Rankine's and Coulomb's theories – Graphical Methods, Culmann's, Trial Wedge methods - Stability checks of cantilever and gravity retaining walls.

**UNIT - IV**

Cantilever and anchored sheet piles - earth pressure diagram - determination of depth of embedment in sands and clays – braced cuts - earth pressure diagrams – forces in struts.

**UNIT – V**

Foundations in Expansive Soils – problems in expansive soils – mechanism of swelling – swell pressure and swelling potential – heave – foundation practices – sand cushion – CNS technique – under-reamed pile foundations – granular pile anchor technique, stabilization of expansive soils.

**TEXT BOOKS:**

- 1) Das, B.M., - (1999) Principles of Foundation Engineering –4<sup>th</sup> edition PWS Publishing, Singapore.
- 2) Bowles, J.E., (1988) Foundation Analysis and Design – 4<sup>th</sup> Edition, McGraw-Hill International.
- 3) Soil Mechanics and Foundation Engineering by V N S Murthy, CBS Publishers and Distributors.

**REFERENCE BOOKS:**

- 1) Geotechnical Engineering Principles and Practices by Cuduto, PHI International.
- 2) Geotechnical Engineering by C. Venkataramah, NewAge International Pvt.Ltd, Publishers (2002).
- 3) Analysis and Design of Substructures – Swami Saran, Oxford & IBH Publishing Company Pvt.Ltd (1998).
- 4) Basics and Applied Soil Mechanics by Gopal Ranjan & ASR Rao, New Age International Pvt.Ltd, Publishers (2002).

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## (A70145) WATERSHED MANAGEMENT

(Elective-II)

### UNIT-I

**Introduction:** Concept of watershed development, objectives of watershed development, need for watershed development in India, Integrated and multidisciplinary approach for watershed management.

**Characteristics of Watershed:** size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics, basic data on watersheds.

### UNIT-II

Watershed delineation – Runoff Computations from a watershed – Flood Frequency Analysis – Gumbell, Log Pearson and Weibull Methods of Analysis.

Planning of watershed management activities, peoples participation, preparation of action plan, administrative requirements

### UNIT-III

**Principles of Erosion:** Types of erosion, factors affecting erosion, effects of erosion on land fertility and land capability, estimation of soil loss due to erosion, Universal soil loss equation.

**Measures to Control Erosion:** Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, rockfill dams, brushwood dam, Gabion.

### UNIT-IV

**Water Harvesting:** Rainwater Harvesting, catchment harvesting, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds, percolation tanks.

### UNIT-V

**Forest and Grass Land Management:** Interpretation of Satellite Imageries-Land use and Land Cover. Land capability classification, management of forest, agricultural, grassland and wild land. Reclamation of saline and alkaline soils.

**Ecosystem Management:** Role of Ecosystem, crop husbandry, soil enrichment, inter, mixed and strip cropping, cropping pattern, sustainable agriculture, bio-mass management, dry land agriculture, Silvi pasture, horticulture, social forestry and afforestation.

### TEXT BOOKS:

1. Watershed Management by JVS Murthy, - New Age International Publishers.
2. Water Resource Engineering by R.Awurbs and WP James, - Prentice Hall Publishers.

### REFERENCE:

1. Land and Water Management by VVN Murthy, - Kalyani Publications.
2. Irrigation and Water Management by D.K.Majumdar, Printice Hall of India.

**(A70136) AIR POLLUTION AND CONTROL**

(Elective -II)

**UNIT – I**

Air Pollution – Definitions, Scope, Significance and Episodes, Air Pollutants – Classifications – Natural and Artificial – Primary and Secondary air pollutants, Point, Line and Areal Sources of air pollution- Stationary and mobile sources. Effects of Air pollutants on man, material and vegetation: Global effects of air pollution – Green House effect, Heat Islands, Acid Rains, Ozone Holes etc.

**UNIT – II**

Meteorology and Plume Dispersion; Properties of atmosphere; Heat, Pressure, Wind forces, Moisture and Relative Humidity, Influence of Meteorological phenomena on Air Quality-wind rose diagrams. Lapse Rates, Pressure Systems, Winds and moisture, plume behavior and plume Rise Models; Gaussian Model for Plume Dispersion.

**UNIT-III**

Control of particulates – Control at Sources, Process Changes, Equipment modifications, Design and operation of control.

Equipment's – Settling Chambers, Cyclone separators, filters, Dry and Wet scrubbers, Electrostatic precipitators.

**UNIT – IV**

Control of gaseous emissions - General Methods of Control of NOx and SOx emissions – In-plant Control Measures, process changes, dry and wet methods of removal and recycling – Adsorption – Absorption – Combustion.

**UNIT – V**

Air Quality Management – Monitoring of SPM, SOx; NOx and CO Emission Standards– Air sampling – Sampling Techniques – High volume air sampler – Stack sampling - Analysis of Air pollutants – Air quality standards – Air pollution control act.

**TEXT BOOKS:**

1. Air pollution By M.N.Rao and H.V.N.Rao – Tata Mc.Graw Hill Company.
2. Air pollution by Wark and Warner.- Harper & Row, New York.

**REFERENCE:**

1. An introduction to Air pollution by R.K. Trivedy and P.K. Goel, B.S. Publications.

**(A70135) ADVANCED STRUCTURAL DESIGN**

(Elective-III)

**UNIT-I**

Design and Detailing of cantilever type of Retaining walls – Stability Check. Principles of Counterfort Retaining walls and shelf type retaining walls.

**UNIT-II**

Design of Circular and Rectangular Water tanks at Ground level and elevated with staging.

**UNIT-III**

Design of Flat slabs- Design of Raft and pile foundations

**UNIT-IV**

Design of Concrete Bridges – IRC loading Design of Stab bridge, T-beam girder bridge.

Introduction to Steel bridges.

**UNIT-V**

Design of RCC Chimneys Bunkers & Silos.

**TEXT BOOKS:**

1. Advanced Reinforced Concrete Structures by Varghese, Pranties Hall of India Pvt. Ltd.
2. Bridge Engineering by S Ponnuswamy Mc Graw Hill Co.
3. Reinforced Concrete Design by S.A. Pillai and D. Menon, Tata Mc. Ghrawhill Publishing Company.
4. Advanced Reinforced Concrete Structures by Krishna Raju.

**REFERENCES :**

1. Reinforced Concrete Structures Vol. 2 by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi, Publications Pvt. Ltd., New Delhi.
2. Essentials of Bridge Engineering by D. John Son Victor, Oxford and IBM Publication Co., Pvt. Ltd.



**(A70137) EARTH AND ROCKFILL DAMS AND SLOPE STABILITY  
(Elective-III)**

**UNIT-I**

**Earth and Rockfill Dams:** General features, Selection of site; Merits and demerits of the earth and rock fill dams, Classification of earth dams, Causes of failure, Safe design criteria. Instrumentation in earth dams: Pore pressure measurements, Settlement gauges, Inclinometers, Stress measurements, Seismic measurements.

**UNIT-II**

**Failures, Damages and Protection of Earth Dams:** Nature and importance of failure, Piping through embankment and foundations, Methods of seepage control through embankments and foundations, Design Criteria for filters, Treatment of upstream and down stream of slopes, Drainage control, Filter design.

**UNIT-III**

**Slope Stability Analysis:** Types of Failure: Failure surfaces - Planar surfaces, Circular surfaces, Non-circular surfaces, Limit equilibrium methods, Total stress analysis versus effective Stress analysis, Use of Bishop's pore pressure parameters, Short term and Long term stability in slopes. Taylor Charts.

**UNIT-IV**

**Methods of Slope Stability:** Method of Slices, Effect of Tension Cracks, Vertical Cuts. Bishop's Analysis, Bishop and Morgenstern Analysis, Non-circular Failure Surfaces: Janbu Analysis, Sliding Block Analysis, Seismic stability, Stabilization of slopes: Soil reinforcement (geosynthetics/soil nailing/micro piles etc), soil treatment (cement/lime treatment), surface protection (vegetation/erosion control mats/shotcrete).

**UNIT-V**

**Rockfill Dams:** Requirements of compacted rockfill, Shear strength of rockfill, Rockfill mixtures, Rockfill embankments, Earth-core Rockfill dams, Stability, Upstream & Downstream slopes.

**Text Books:**

1. Sherard, Woodward, Gizienski and Clevenger. Earth and Earth-Rock Dams. John Wiley & Sons. 1963.

**References:**

1. Bharat Singh and Sharma, H. D. – Earth and Rockfill Dams, 1999
2. Sowers, G. F. and Salley, H. I. – Earth and Rockfill Dams, Willams, R.C., and Wallace, T.S. 1965.
3. Abramson, L. W., Lee, T. S. and Sharma, S. - Slope Stability and Stabilisation methods – John Wiley & sons. (2002)
4. Bromhead, E. N. (1992). The Stability of Slopes, Blackie academic and professional, London.
5. Christian, Earth & Rockfill Dams – Principles of Design and Construction, Kutzner Published Oxford and IBH.
6. Ortiago, J. A. R. and Sayao, A. S. F. J. - Handbook of Slope Stabilisation, 2004.

IV Year B.Tech. CE-I Sem	L	T/P/D	C
	4	-/-	4

**(A70144) WATER RESOURCES SYSTEMS ANALYSIS**

**(Elective-III)**

**UNIT - I**

**Introduction:** Definition of system, Types of systems, System approach, System analysis and types of systems, Techniques of water resources system analysis.

**Systems Techniques in Water Resources:** Objective function and constraints, optimization using calculus, Optimization of a function of single variable, Optimization of a function of multiple variables, Constrained optimization, Kuhn – Tucker conditions.

**UNIT - II**

**Linear programming –I:** Formulation of linear programming models, graphical method, simplex method, application of Linear programming in water resources.

**UNIT - III**

**Linear programming –II:**

Revised simplex method, duality in linear programming, sensitivity and post optimality analysis.

**UNIT - IV**

**Dynamics programming:** Belman's principles of optimality forward and backward recursive dynamic programming, curse of dimensionality, application of dynamic programming for resource allocation.

**UNIT - V**

**Water Resources Economics:** Basics of Engineering economics, Discount factors, Uniform annual series, Amortization, Comparison of alternate plans. Principles of Economics analysis, Conditions of project optimality, benefit cost analysis socio economic intuitional and pricing of water resources.

**TEXT BOOKS:**

- 1 Water Resources System Analysis – Vedula & Mujumdar – Tata Mc. Graw Hill Company Ltd.
- 2 Water Resources Economics - James & Lee. Oxford Publishers 2005.

**REFERENCES:**

- 1 Operational Research by Taha, Printice Hall of India publishers.
- 2 Water Resources project Economic by Kuiper.E.
- 3 Engineering optimization: Theory and Practice, Rao, Singiresu S. New Age International.

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**(A70139) INDUSTRIAL WASTE WATER TREATMENT**

**(Elective-III)**

**UNIT – I**

Sources of Pollution – Physical, Chemical, Organic and Biological properties of Industrial Wastes – Differences between industrial and municipal waste waters – Effects of industrial effluents on sewers and Natural Water Bodies.

**UNIT – II**

Pre and Primary Treatment – Equalization, Proportioning, Neutralization, Oil Separation by Flootation – Waste Reduction - Volume Reduction – Strength Reduction.

**UNIT – III**

Waste Treatment Methods – Nitrification and De-nitrification – Phosphorous removal – Heavy metal removal – Membrane Separation Process – Air Stripping and Absorption Processes – Special Treatment Methods – Disposal of Treated Waste Water.

**UNIT – IV**

Characteristics and Composition of waste water and Manufacturing Processes of Industries like Sugar, Characteristics and Composition of Industries like Food Processing Industries, Steel, Petroleum Refineries,

**UNIT – V**

Characteristics and Composition of Industries like Textiles, Tanneries, Atomic Energy Plants and other Mineral Processing Industries - Joint Treatment of Raw Industrial waste water and Domestic Sewage – Common Effluent Treatment Plants (CETP) – Location, Design, Operation and Maintenance Problems – Economical aspects.

**TEXT BOOKS**

1. Industrial Waste Water Pollution Control by W. Wesley Eckenfelder – McGraw-Hill.
2. Industrial Waste Treatment by Rao & Datta.

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IV Year B.Tech. CE-I Sem

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## (A70195) CONCRETE AND HIGHWAY MATERIALS LAB

### I. ROAD AGGREGATES:

1. Aggregate Crushing value
2. Aggregate Impact Test.
3. Specific Gravity and Water Absorption.
4. Attrition Test
5. Abrasion Test.
6. Shape tests

### II. BITUMINOUS MATERIALS:

1. Penetration Test.
2. Ductility Test.
3. Softening Point Test.
4. Flash and fire point tests.

### III. CEMENT AND CONCRETES :

#### TESTS ON CEMENTS :

1. Normal Consistency of fineness of cement.
2. Initial setting time and final setting time of cement.
3. Specific gravity and soundness of cement.
4. Compressive strength of cement.
5. Workability test on concrete by compaction factor, slump and Vee-bee.
6. Young's modulus and compressive strength of concrete.
7. Bulking of sand.
8. Non-Destructive testing on concrete (for demonstration).

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## (A70192) ENVIRONMENTAL ENGINEERING LAB

### LIST OF EXPERIMENTS

1. Determination of pH and Turbidity
2. Determination of Conductivity and Total dissolved solids (Organic and Inorganic)
3. Determination of Alkalinity/Acidity.
4. Determination of Chlorides.
5. Determination of iron.
6. Determination of Dissolved Oxygen.
7. Determination of Nitrates.
8. Determination of Optimum dose of coagulant
9. Determination of Chlorine demand
10. Determination of total Phosphorous.
11. Determination of B.O.D
12. Determination of C.O.D
13. Determination of Optimum coagulant dose.
14. Determination of Chlorine demand.
15. Presumptive coliform test.

NOTE : At least 8 of the above experiments are to be conducted.