

**Syllabus of the subjects modified for the above course  
structure Core course**

**CE 201**

**Surveying**

**(3-0-0-6)**

**Course Content**

Introduction to surveying; Linear measurements;; Angle and direction measurements Accuracy, precision and errors; Combined distance and angular measurements; Resection and Intersection; Leveling; Contouring, Trigonometrical surveying; Triangulation; Advanced survey instruments: Electronic distance measurement, Total station and Global Positioning System; Application of surveying (eg. curves etc.) ; Introduction to photogrammetry and remote sensing.

**Text books:**

1. W. Schofield and M. Breach, *Engineering Surveying*, 6<sup>th</sup> Edn., CRC Press, 2007.
2. C.D. Ghilani and P.R. Wolf, *Elementary Surveying*, Prentice Hall, 2014.
3. E.M. Mikhail and J.M. Anderson, *Surveying: Theory and Practice*, McGraw Hill, 2013.
4. T. P. Kanetkar and S. V. Kulkarni, *Surveying and Levelling, Vol-I and Vol-II*, Pune Vidyarthi Griha Prakshan, 1972.
5. B.C. Punmia, A.K. Jain & A.K. Jain, *Surveying, Vol-I and Vol-II*, Laxmi Publication Pvt., 1996.
6. T.M. Lillesand, and R.W. Kiefer, *Remote Sensing and Image Interpretation*, John Wiley & Sons, 1994.

**Reference books:**

1. J.V. Sickle, *GPS for Land Surveyors*, CRC Press, 2008
2. G. Joseph, *Fundamentals of Remote Sensing*, Universities Press, 2003
3. R.C. Brinker and R. Minnick, *The Surveying Handbook*, Springer Science+ Business Media, B.V., 1995.
4. D. Clark, *Plane and Geodetic Surveying for Engineers*, Vol. 1 & Vol. 2, CBS, 2004.

**CE 203**

**Fluid Mechanics**

**(3-0-0-6)**

**Course Content :**

Fluid properties; Pressure measurement; Hydrostatic forces on plane and curved surfaces; metacentric height; Types of flow; Continuity; Energy and momentum equations; Velocity distribution and velocity coefficients, practical applications; Navier-Stokes equation; Shear stress and pressure gradient; Flow through pipes, Hagen-Poiseuille equation; Turbulence, Prandtl's mixing length, eddy viscosity; Darcy-Weisbach equation for flow through pipes, friction factor, Moody diagram, minor losses, pipes in series and parallel, equivalent length, pipe network analysis; Boundary layer concept, drag coefficients, control of boundary layer; Dimensional analysis and similitude.

**Texts:**

1. F.M. White, *Fluid Mechanics*, McGraw Hill, 1994.
2. V.L. Streeter and E.B. Wylie, *Fluid Mechanics*, McGraw Hill, 1997.
3. P.N. Modi and S.M. Seth, *Hydraulics and Fluid Mechanics*, Standard Book House, 1998.

**References:**

1. M.K. Goyal, *Fluid Mechanics and Hydraulic Machines*, PHI Learning Pvt. Ltd., 2015.
2. K. S. Massey, *Mechanics of Fluids*, Van Nostrand Reinhold Co., 1979.
3. J. Frabzini, *Fluid Mechanics with Engineering Applications*, McGraw Hill, 1997.
4. J.H. Spurk, *Fluid Mechanics – Problems and Solutions*, Springer, 2003.

## **CE 211 CIVIL ENGINEERING MATERIALS**

**(3-0-0-6)**

### **Course Content:**

Introduction to structures of solids, ductility, brittleness, strength, stiffness, durability, hardness, toughness; Weakness of materials, Introduction to building materials, Cement: Chemical composition, manufacturing, physical characteristics, hydration, properties of cement compounds, different types of cements, Aggregate: Coarse and fine aggregates, Influence of aggregate on the properties of concrete, aggregate selection, Fresh Concrete: Batching, Mixing, workability, effect of admixture, Hardened Concrete: mechanical properties of hardened concrete, Water-cement ratio, Porosity, Curing of concrete, High performance concrete, Design of concrete mix: IS code recommendation, British code and ACI code, Deterioration of concrete : Corrosion, chloride and sulphate attack on concrete, alkali-aggregate reaction, acid aggregate reactions, Brick: Raw materials, drying and burning, Strength and durability, mortar for masonry and strength of masonry, Timber, Seasoning and conversions, properties, tests, defects in timbers, Glass: Chemical compositions, mechanical and optical properties, Various types of glasses, Strengthening of glasses, Metals, steel for reinforced concrete.

### **Texts:**

1. S. Somayaji, *Civil Engineering Materials*, Prentice Hall, New Jersey, 2001.
2. M. S. Mamlouk, and J. P. Zaniewski, *Materials for Civil and Construction Engineers*, Pearson, Prentice Hall, 2<sup>nd</sup> Edn., 2006.
3. A. M., Neville and J. J. Brooks, *Concrete Technology*, Pearson Education, Fourth Indian reprint, 2004.

### **References:**

1. N. Jackson, and R. K. Dhir, *Civil Engineering materials*, Macmillan, 4<sup>th</sup> Edn., 1997.
2. M. S. Shetty, *Concrete Technology*, S. Chand and Company Ltd. 2005.
3. P. C. Aitcin, *High Performance Concrete*, E & F Spon, 1998.
4. J. F. Shackelford and M. K. Muralidhara, *Introduction to Material science for Engineers*, Pearson Education, 6<sup>th</sup> Edn., 2007.

**CE 214****FLUID MECHANICS LAB****(0-0-2-2)****Course Content :**

Measurement of fluid pressure using various manometers and gauges., Experimental study on capillarity, Determination of coefficient of viscosity of a fluid using viscometer, Experimental study on stability of floating bodies, Study on fluid pressure distribution on immersed bodies, Study of different types of flow using Reynold's apparatus, Determination of friction factor in pipes using pipe friction apparatus., Experimental study on flow nets using Hele-Shaw apparatus, Experimental study on cavitations.

**Texts/References:**

1. T.S. Deshmukh, *Fluid Mechanics & Hydraulic Machines*, (A Lab Manual), Laxmi Publications, 2001.
2. K. L. Kumar, *Engineering Fluid Mechanics*, Eurasia Publishing Company (P) Ltd., New Delhi, 1999.

**CE 220 ENVIRONMENTAL ENGINEERING - I****(3-0-0-6)****(Shifted with its lab component CE315 to 4<sup>th</sup> Semester from 6<sup>th</sup> semester)****Course content:**

Introduction, Population Forecasting and Water Demand, water supply and distribution, Physical, Chemical and Biological Characteristics of Water and Wastewater, Wastewater Flow, Sewerage system and sewer design, Basic Microbiology: cells, classification and characteristics of living organisms. Metabolic Processes, Microorganisms in Natural Water Systems, Biological Oxidation of Organic Matter. Introduction to Environmental Chemistry, Stoichiometry and Kinetics of Chemical Reactions, Equilibrium Constant and Solubility Products, pH and Alkalinity. Development of Oxygen Sag Model. Flow sheets for Water and Wastewater Treatment, Introduction to Solid Waste, Air Pollution and Noise Pollution.

**Texts:**

1. H. S Peavy, D. R. Rowe and G. Tchobanoglous, *Environmental Engineering*, McGraw-Hill International Ed., 1985.
2. T. J. McGhee, *Water Supply and Sewerage*, McGraw-Hill Inc., 1991.

**References:**

1. M. L. Davis, and D. A. Cornwell, *Introduction to Environmental Engineering*, McGraw-Hill, Inc., 1991.
2. Metcalf & Eddy, *Wastewater Engineering- Treatment and Reuse* (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.
3. C. N Sawyer, P. L. McCarty and G. F. Parkin, *Chemistry for Environmental Engineers*, McGraw- Hill, 1994.
4. APHA, *Standard Methods Examination of Water and Wastewater*, American Public Health Association, Washington DC, 1995.
5. *Manual for Sewer and Sewerage*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1993.
6. *Manual for water supply and treatment*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

**CE 221 ENVIRONMENTAL ENGINEERING - I LAB (0 0 2 2)**

Solid analysis; pH, Alkalinity, Turbidity and Conductivity measurements; Estimation of Hardness, Dissolved Oxygen, BOD and COD; Plate Counts and MPN test; Estimation of Fluoride and metals using colorimetric methods, Introduction to advance instruments i.e. Atomic Adsorption Spectroscopy (AAS).

**Texts/References:**

1. C. N. Sawyer, P. L. McCarty and G. F. Parkin, *Chemistry for Environmental Engineers*, McGraw-Hill, 1994.
2. APHA, *Standard Methods Examination of Water and Wastewater*, American Public Health Association, Washington DC, 1995.
3. *Manual for Sewer and Sewerage*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1993.
4. *Manual for water supply and treatment*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

## **CE 222 HYDRAULICS AND HYDRAULIC STRUCTURES (3-0-0-6)**

### **Course Content :**

Open channel hydraulics, uniform flow, critical flow, Gradually varied flow, hydraulic jump, unsteady flow; Channel design, erodible and non erodible channels, silt theories, sediment transport; Introduction to river engineering, meandering, river training works; Introduction to Dam engineering, classification of Dams, design of spillway; Basic principle of design of hydraulic structures; Layout of canal systems, Cross drainage works.

### **Texts:**

1. H.M. Chaudhry, *Open Channel Flow*, Prentice Hall of India, 1998.
2. V.T. Chow, *Open Channel Flow*, McGraw Hill, 1975.
3. S.K. Garg, *Irrigation Engineering and Hydraulic Structures*, Khanna Publishers, 1992.

### **References:**

1. K. Subramanya, *Flow in Open Channels*, Tata McGraw Hill, 1998.
2. V.L. Streeter and E.B. Wylie, *Fluid Mechanics*, McGraw Hill, 1997.
3. B.F. White, *Fluid Mechanics*, McGraw Hill, 1994.
4. B.C. Punmia, *Irrigation and Water Power Engineering*, Standard Publishers, 1992
5. J. Frabzini, *Fluid Mechanics with Engineering Applications*, McGraw Hill, 1997.

## **CE 223 HYDRAULICS AND HYDRAULIC STRUCTURES LAB (0-0-2-2)**

### **Course Content:**

Determination of resistance coefficient in open channels, Experimental study on variation of specific energy with depth of flow in open channels, Measurement of flow using weirs and notches, Measurement of flow using a Parshall flume, Experiments on gradually varied flow (GVF) in open channels, Experimental study on hydraulic jumps.

### **Texts/References:**

1. P.N. Modi and S.M. Seth, *Hydraulics and Fluid Mechanics*, Standard Book House, 1998.
2. K. L. Kumar, *Engineering Fluid Mechanics*, Eurasia Publishing Company (P) Ltd., New Delhi, 1999.

## **CE 304                    TRANSPORTATION ENGINEERING - I (3-0-0-6)**

### **Course Content:**

Introduction to transportation engineering; Classification of roads; Geometric design of highways: cross sectional elements, sight distance and its application, super elevation, horizontal alignment, vertical alignment; Pavement types and components of a pavement structure; Role, design and experimental characterization of different pavement materials including: subgrade soil, aggregates, asphalt, modified asphalt, emulsion, cutback, bituminous mix and cement concrete mix; Analysis of pavement structures and design considerations; Design of flexible pavements, Design of rigid pavements; Introduction to Superpave method of pavement material characterization.

### **Texts and References:**

1. P. Chakroborty and A. Das, *Principles of Transportation Engineering*, Prentice Hall India, 2003.
2. S.C. Saxena and S.P. Arora, *A text book of Railway Engineering*, Dhanpat Rai, 2001.
3. C.J. Khisty and B.K. Lall, *Transportation Engineering: an introduction*, Prentice Hall India, 2003.
4. N.J. Garber and L.A. Hoel, *Traffic and Highway Engineering*, Cengage Learning, 2014.
5. F.L. Mannering, W.P. Kilareski and S.S. Washburn, *Principles of Highway engineering and traffic analysis*, John Wiley and Sons, 2005.
6. C.S. Papacostas and P.D. Prevedouros, *Transportation Engineering and Planning*, Prentice Hall India, 2001.
7. J.H. Banks, *Introduction to Transportation Engineering*, McGraw-Hill, 2002.
8. N.A. Harold, *Highway materials, Soil and Concrete*, Prentice Hall, 2004.
9. S.K. Khanna, C.E.G. Justo and A. Veeraragavan, *Highway Engineering*, Nem Chand Bros., 2002.
10. Y. H. Huang, *Pavement Analysis and Design*, Pearson Education, India 2008.
11. Relevant codes from Indian Roads Congress (IRC), Bureau of Indian standards (BIS) and Asphalt Institute Manuals (AI).

# CE 308 CONSTRUCTION TECHNOLOGY AND MANAGEMENT (3 0 0 6)

## Course Content:

Construction as industry and its challenges, Role of construction management, Methods of construction management, Life cycle of construction projects, Stages of awarding contract, types of contract, contract laws, contract documents, arbitration and settlement of disputes.

Principles of estimation, Principles of general and detailed specifications, Introduction to network based project management techniques: Defining activities and their interdependence, drawing of network, time and resource estimations, use of network as scheduling techniques, use of network as control techniques i.e. project monitoring, Construction Technology: construction of superstructure and substructures of various structures, Various construction methods: Excavation, Earth-moving, Drilling, Blasting, Dewatering, foundation, Finishing items, painting, flooring, brick works, Quality Management and Construction safety, Use of information technology in construction industry, Automation in construction industry: a general discussion.

## Texts:

1. F. Harris, R. McCaffer and F. Edum-Fotwe, *Modern Construction Management*, Blackwell Publishing, 2006.
2. C. J. Schexnayder and R. E. Mayo, *Construction Management Fundamentals*, McGraw Hill, New Delhi, 2003.
3. R.L. Peurifoy and C.J. Schexnayder, *Construction planning and equipment, and methods*, 6<sup>th</sup> Edn., Tata McGraw-Hill, 2006.

## References:

1. J. Singh, *Heavy Constructon-Planning, equipment and methods*, Oxford & IBH Publishing Co. Pvt 1993.
2. D.S. Berrie and B.C. Paulson, *Professional construction management including C.M., Design construct and general contracting*, 3<sup>rd</sup> Edn., McGraw Hill International edition, 1992.
3. L.S. Srinath, *PERT and CPM principles and Applications*, 3rd Edn., Affiliated east-west press Pvt Ltd, 2001.
4. D.G. Carmichael, *Construction engineering Networks: Techniques, planning and management*, Ellis Horwood Publishers Chichester 1989.
5. K.K. Chitkara, *Construction project management: planning, scheduling and controlling*, Tata McGraw-Hill, 2008.



## **CE 316ENVIRONMENTAL ENGINEERING - II**

**(3 0 0 6)**

Particle Fluid Mechanics as applied to the settling of Type I and II suspensions. Design and operation of Sedimentation Tanks. Coagulation and Flocculation. Hydraulics of Filtration, Design and Operation of Filter Units. Disinfection Methods. Ion exchange and Adsorption. Water Softening, Manganese and Iron Removal. Wastewater Treatment – Preliminary, Primary and Secondary Treatment Units. Aerobic and Anaerobic Processes. Purpose, theory and design of aeration units. Sludge treatment and disposal, Wastewater stabilization ponds, Aerated ponds and Oxidation ditches. Site-visits to Water and Wastewater Treatment Works.

### **Texts:**

1. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, *Environmental Engineering*, McGraw-Hill International Ed., 1985.
2. Metcalf & Eddy, *Wastewater Engineering- Treatment and Reuse* (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.

### **References:**

1. T. J. McGhee, *Water Supply and Sewerage*, McGraw-Hill, Inc, 1991.
2. J. M. Montgomery, *Water Treatment Principles and Design*, John Wiley & Sons, 1985
3. M. L Davis and D. A Cornwell, *Introduction to Environmental Engineering*, McGraw-Hill, Inc., 1991.
4. S. J. Arceivala and S. R. Asolekar, *Wastewater Treatment for Pollution Control and Reuse*, Tata McGraw Hill, 2006.
5. *Manual for Sewer and Sewerage*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1993.
6. *Manual for water supply and treatment*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

## **CE 320ENGINEERING GEOLOGY (3 0 2 8)**

The Earth: a system approach; Earth Processes and their consequences: Lithosphere, Hydrosphere, Cryosphere, Atmosphere, Biosphere and interconnectedness; Earth Materials: rocks, soils, minerals; Engineering and Genetic classification of rocks; Rock mechanics; **Strength Properties of Rocks: Rock Mass Strength; Weathering; Structures: Folds, Faults, Joints; Plate Tectonics, Earthquakes: Causes, classification, magnitude, intensity, seismic hazards zoning;; Groundwater: resources and quality; Site Investigation: S. I. Desk Study; Remote sensing, GIS and GPS: Basic principles and applications, Boreholes; Landslides and Subsidence: causes, classification and monitoring; Rock excavation: Cut Slopes in rocks; Criteria and factors for site selection for dams, tunnels, waste/radioactive disposal sites.**

*Experiments:* Rocks and Minerals and their Engineering Properties (UCS, Schmidt Hammer), Identification by Megascopic Hand Specimen studies of Rock and Mineral Samples, Petrological Microscopic Study of Rock Sections and their Properties-1, Exercise on Structural Geologic Maps, Core Loss and RQD, Stereographic projection and contouring, Characterizing Discontinuity Patterns, Engineering Geologic Maps, Resistivity survey to interpret sub-surface geology, Hydrogeological experiment/ exercise, Field Trip.

### **Texts:**

1. K.Gokhale, *Principles of Engineering Geology*, 1<sup>st</sup> Edn., B S Publications, Hyderabad, 2005.
2. A. C. Waltham, *Foundations of Engineering Geology*, 1<sup>st</sup> Edn., Blackie Academic & Professional, Chapman & Hall, 1997.

### **References:**

1. K. Allan, *General Geology for Engineers*, Prentice & Hall, 1995.
2. P. Kesavulu, *Engineering Geology*, Oxford University Press, 2nd Edn., 1999.
3. P. Singh, *Engineering and General Geology*, S. K. Kataria and Sons, 6th Edn., 1999.

## **CE 321 TRANSPORTATION ENGINEERING II (3-0-0-6)** **(Shifted to 6<sup>th</sup> Semester from 7th)**

### **Course Content:**

Introduction to Traffic and Transportation Planning; Introduction to probability and Statistics; Traffic flow fundamentals; Uninterrupted Traffic flow: Traffic stream characteristics, Traffic flow models, capacity and LOS analysis; Interrupted Traffic flow: Traffic flow at signalized and un signalized intersections; Traffic regulations and control: Traffic Signals, Signs, Markings, Islands; Design of Traffic facilities: Highways, intersection, interchanges, parking; Transportation planning: Introduction to planning, Travel demand forecasting; Four step planning: Trip Generation, Trip distribution, Modal split, Assignment; Advance methods for travel demand forecasting.

**Texts/References:**

1. C.S. Papacostas, and P.D. Prevedouros, *Transportation Engineering and Planning*, Prentice Hall India, 2001.
2. P. Chakroborty and A. Das, *Principles of Transportation Engineering*, Prentice Hall India, 2003.
3. R.P. Roess, W.R. McShane and E.S. Prassas, *Traffic Engineering*, Prentice Hall, 1990.
4. C.J. Khisty and B.K. Lall, *Transportation Engineering: an introduction*, Prentice Hall India, 2003.

**CE 322      Transportation Engineering-II Laboratory      (0-0-2-2)**  
**(Shifted to 6<sup>th</sup> Semester from 7<sup>th</sup>) Course number may be reassigned)****Laboratory**

Headway studies: Free flow, Intermediate flow, and Congested Flow conditions; Speed studies; Speed-Volume studies; Moving observed method; Signal design; Parking studies; O-D survey; Driver Vision testing; Traffic simulation.

**CE 323                      ENGINEERING HYDROLOGY                      (3-0-0-6)**  
**(New name to CE 311: Hydrology and Water Resources Engineering (3-0-0-6)**  
**to be taught in 6<sup>th</sup> semester in the proposed curriculum)****Course Content:**

Surface water hydrology - hydrologic cycle, rainfall and its measurement, mean rainfall, runoff; Flow measurements; Infiltration losses; Stormhydrology; Unit Hydrograph; Storm hydrograph; Reservoir planning - Investigations, life of reservoir; Flood estimation and routing, floodforecasting; Surface and sub-surface drainage, water logging, remedial measures, drainage of land; Introduction to Ground water hydrology - Soil-Water-Plant relationships, crop water requirement.

**Texts:**

1. K. Subramanya, *Engineering Hydrology*, TMH, New Delhi, India, 2013.
2. V.T. Chow, D.R. Maidment and L.W. Mays, *Applied Hydrology*, McGraw Hill, 1998.
3. V.P. Singh, *Elementary Hydrology*, Prentice Hall, 1993.

**References:**

1. H.M. Raghunath, *Hydrology – Principles, Analysis and Design*, Wiley Eastern Ltd., 1986.
2. A.M. Michael, *Irrigation – Theory and Practice*, Vikas Publishing House, 1987.
3. D.K. Todd, *Groundwater Hydrology*, John Wiley & Sons, 1993.
4. K. Linsley, *Water Resources Engineering*, McGraw Hill, 1995.
5. S.K. Garg, *Irrigation Engineering and Hydraulic Structures*, Khanna Publishers, 1992.
6. H.P. Ritzema (Editor-in-Chief), *Drainage Principles and Applications*, ILRI Publication 16, 1994.

**CE 324**

**HYDROLOGY LAB**

**(0-0-2-2)**

**Course Content:**

Experimental study of rain-guage, Measurement of evaporation using evaporation pan, Measurement of infiltration using various types of Infiltrometer, Experiment on Tensiometer, Measurement of velocity using currentmeter-ADV & ADCP, Measurement of depth using Eco-Sounder, Experiment study on rainfall simulator.

**Texts/References:**

1. H.M. Raghunath, *Hydrology – Principles, Analysis and Design*, Wiley Eastern Ltd., 1986.
2. A.M. Michael, *Irrigation – Theory and Practice*, Vikas Publishing House, 1987.

**CE 432**

**HYDRAULIC MACHINES**

**(3-0-0-6)**

(Elective course)

**Course Content:**

Introduction – pumps, centrifugal pump, reciprocating pump, slip, indicator diagram, air vessels, hydraulic transient, specific speed, characteristic curves, cavitation, multi-stage pumps, screw pump, jet pump; Turbines, classification, Pelton Wheel, Francis Turbine, Kaplan Turbine, specific speed, selection of turbines; Mini power plant – planning; Miscellaneous hydraulic pumps and machines – submersible pump, gear pump, screw pump, sewage pump, hydraulic press, hydraulic accumulator, hydraulic ram.

**Texts / References:**

1. P.N. Modi and S.M. Seth, *Hydraulics and Fluid Mechanics*, Standard Book House, 1998.
2. J. Lal, *Hydraulics Machines*, Metropolitan Book Co., 1969.
3. I. J. Karassik, J. P. Messina, P. Cooper and C. C. Heald, *Pump Handbook*, McGraw-Hill, 3<sup>rd</sup> Edn., 2001.
4. T. Jiandong, Z. Naibo, W. Xianhuan, H. Jing and D. Huishen, *Mini- Hydropower*, John Wiley & Sons, 1997.

## **CE 434 GROUNDWATER HYDROLOGY AND MANAGEMENT (3-0-0-6)**

### **Course content:**

Introduction to groundwater hydrology; Well and aquifer characteristics; Groundwater flow in aquifers, groundwater recharge, fluctuation of water table beneath a recharge site; Hydraulics of fully and partially penetrating wells in confined, leaky and unconfined aquifers under steady and transient conditions; Analysis of pumping test data; Groundwater investigations; Basin management of groundwater and ground water quality; Model studies; Sea water intrusion.

### **Texts/ References:**

1. D.K. Todd, *Groundwater Hydrology*, John Wiley & Sons, 1993.
2. C. Walton, *Groundwater Resources Evaluation*, McGraw Hill, 1970.
3. H.M. Raghunath, *Groundwater Hydrology*, New Age International, 1993.
4. O.D.L. Strack, *Groundwater Mechanics*, Prentice Hall, 1989.
5. S.P. Garg, *Groundwater and Tube Wells*, Oxford & IBH Publishing Co., 1993

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