

**Vocational Higher Secondary
Education (VHSE)**

Second Year

**CIVIL CONSTRUCTION
TECHNOLOGY**

Reference Book - Teachers' Version



Government of Kerala
Department of Education

State Council of Educational Research and Training (SCERT),
KERALA
2016

Foreword

Dear Teachers

This reference book (**Teachers' Version**) is intended to serve as a transactional aid to facilitate classroom transaction and as a ready reference for teachers of Vocational Higher Secondary Schools. It offers some guidelines for the transaction of the course content and for undertaking the practical work listed in the course content. As the curriculum is activity based, process oriented and rooted in constructivism focusing on the realisation of learning outcomes, it demands higher level proficiency and dedication on the part of teachers for effective transaction.

In the context of the Right- based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of the teachers' version of reference books has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

Dr. J. Prasad
Director
SCERT, Kerala

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About the Course

Civil engineering is one of the oldest disciplines of engineering which can be dated back to the first time when somebody laid tree across a river to cross it. It is one of those branches of engineering which have both a scientific as well as artistic aspect to it. Construction of structures is a major activity of civil engineering. At the same time, water resources engineering and environmental engineering are also another two major disciplines of this subject.

In the first two modules named ADVANCED SURVEYING, CIVIL COSTRUCTION and DRAFTSMANSHIP, in the first year the students step into the preliminary part of construction. During the second year another two modules incorporated are ESTIMATING AND COSTING, WATER SUPPLY and SANITARY ARRANGEMENTS in buildings. All these four disciplines are the at most needed topics in view of its importance in the present trends of construction industry. A lot of work force is needed in this sector in skilled level, semi skilled level and supervisory level in India and internationally.

Study of Estimating and costing reduces the wastage of money, time, labour, etc. in construction. It also helps in scheduling all the above parameters properly so as to acquire optimum output from minimum resources.

Study of Water Supply and Sanitary arrangements helps to utilize the most precious resource water with planning so that huge amount of money can be saved in water supply schemes and supply wholesome water can be distributed to the society .

6. JOB ROLES

1. Plumber
2. Quantity Surveyor of water supply and sanitary fittings
3. Store keeper in construction Industries for inventory control of plumbing materials
4. Work Inspector of construction sites(water supply & sanitary fittings)
5. Contractor in water supply & sanitary works
6. Plumbing Supervisor
7. Dealer in supplying water supply & sanitary fittings
8. Marketing Executive
9. Irrigation Technician
10. Sales Executive
11. Customer Relations Manager
12. Quantity Surveyor
13. Estimation Assistant
14. Valuer in financial institutions
15. Construction Manager
16. Project Supervisor

ABOUT THE COURSE

Civil engineering is one of the oldest disciplines of engineering which can be dated back to the first time when somebody laid tree across a river to cross it..It is one of those branches of engineering which have both a scientific as well as artistic aspect to it. .Construction of structures is a major activity of civil engineering. At the same time water resources engineering and environmental engineering also another two major disciplines of this subject.

In the first two modules named ADVANCED SURVEYING & CIVIL COSTRUCTION AND DRAFTSMANSHIP the students step into the preliminary part of construction .During the second year another two modules incorporated are ESTIMATING AND COSTING and WATER SUPPLY and SANITARY ARRANGEMENTS in buildings. All these four disciplines are the at most needed topics in view of its importance in the present trends of construction industry. Since a lot work force is needed in this sector in skilled level, semi skilled level and supervisory level not only in India but also internationally.

Study of Estimating and costing reduces the wastage of money, time, labour etc in construction. It also helps in scheduling all the above parameters properly so as to acquire optimum output from minimum resources.

Study of Water Supply and Sanitary arrangements helps to utilize the most precious resource water with planning so that huge amount of money can be saved in water supply schemes and supply wholesome water to society.

ABOUT THE COURSE The Civil Construction Technology course aims to mould professionals at supervisor level using entrepreneurship skills. The CCT is a multi-skill development course with intensive learning on Surveying, construction, Quantity surveying and Plumbing services.

7 .MAJOR SKILLS (WITH SUB SKILLS)

MEASURING SKILL

ESTIMATION SKILL

TABULATION SKILL

EXECUTION SKILL

MANAGEMENT SKILL

ORGANISATION SKILL

DRAFTING SKILL

ANALYSING SKILL

SUPERVISING SKILL

PLANNING SKILL

LOGICAL REASONING SKILL

CO-ORDINATING SKILL

COMMUNICATING SKILL

REASONING SKILL

8. LEARNING OUTCOMES OF THE COURSE

The learner

- Performs land survey to prepare plan and calculate area of a plot
- Handle modern survey equipments for the survey
- Select appropriate materials for construction
- Supervise work execution sites
- Draft with Computer aided drafting software
- Set out buildings
 - Calculates the quantity of various items of construction works
 - Prepares the detailed estimate for different types of construction works.
 - Value an existing building .
 - Understands the method of awarding civil public works through tenders and entering of measurements in M book etc
 - Manage the construction project effectively by planning & scheduling time ,labour and cost.
 - Prepare the lay out plan of water supply system including rain water harvesting unit for a building with its estimate.
 - Perform and supervise the water supply and plumbing works of buildings including its repair.
 - Prepare the sanitary lay out of a building with estimate
 - Perform and supervise the sanitary works of buildings including its repair.

9. COURSE STRUCTURE

Module No	Module Name	Periods
1	Advanced Surveying	340
2	Civil Construction & Draftsmanship	340
3	Quantity Surveying & costing	340
4	Water Supply & Sanitary arrangements	340

CIVIL CONSTRUCTION TECHNOLOGY

MODULE 3 - QUANTITY SURVEYING & COSTING

SYLLABUS

Unit 3.1 – Introduction to Quantity Survey

Estimation – Purpose of estimation – Data required to prepare an estimate – Standard units of measurement – units and modes of measurement as per IS 1200 – Types of areas – Plinth area, floor area, carpet area and circulation area – Specification of items of work – necessity of specification- General specification of I class buildings – Detailed specifications of different items of work - Earthwork excavation, PCC works, RR masonry, Brick masonry, and plastering. 49 periods

Unit 3.2 – Types of Estimate

Preliminary or approximate estimate – Plinth area estimate – Cubical content estimate – detailed estimate – work charged establishment – different methods of estimation of buildings – Exercises of residential buildings – Bar bending schedule. 188 periods

Unit 3.3 – Analysis of Rates

Factors affecting cost of an item of work – schedule of rates – Analysis of rates of different items of work-Earth work excavation in ordinary soil and hard soil-PCC work and RCC works, RR masonry and Brick masonry – Analysis of rates and preparation of abstract of cost using spreadsheet. 15 periods

Unit 3.4 - Contracts & Tenders

Contract – Tender – Earnest money deposit – Security deposit – kinds of contracts – work order form – Administrative approval – Technical approval - Procedure for inviting tender – invitation of tenders – e – tender – contract agreement – conditions of contract – obligations of contractor, engineer and client – measurement book- muster roll. 10 periods

Unit 3.5 – Network Analysis

Introduction – developing a network using CPM – developing network using PERT - difference between PERT and CPM – construction safety management. 10 periods

Unit 3.6 – Valuation of buildings

Factors affecting the value of a property – purpose of valuation – valuation based on cost – valuation based on profit – methods of valuation – sinking fund method – depreciation method – Quantity survey method - mortgage – annuity – rent fixation.

68 periods **16. PRACTICAL ACTIVITIES**

MODULE III

Plinth area calculation:(25 periods)

- Prepare the plan, elevation and section of a two storied residential building and find out the plinth area.

Measurement Practice:(35 periods)

- Measure the dimensions of a compound wall.
- Measure the dimensions of a single room and prepare the sketch (Inner and outer dimensions)
- Measure the dimensions of all components of a residential building and prepare the line sketch.

Quantity survey:(38 Periods)

Calculation of quantities of following items of work by measuring the dimensions of an existing building/ building under construction.

- Earth work in Excavation for foundation
- RR Masonry for foundation and basement
- Masonry for super structure
- RCC works
- Plastering
- Floor finishing works

Estimation (Long wall Short wall method (40 Periods)

- Estimation of quantities of items of a compound wall.
- Estimation of quantities of items of a single room.
- Estimation of quantities of items of a residential building.
- Estimation of quantities of items of a school building.

Estimation (Centre line method):(100 Periods)

- Preparation of detailed estimate using given centre line plan.
- Preparation of detailed estimate using centre line method for a given plan.

- **Project:** Prepare the plan, section and elevation of a residential detailed estimate.

MODULE -4**WATER SUPPLY & SANITARY ARRANGEMENTS****UNIT 4.1****SOURCES AND TREATMENT OF WATER(5 HRS)**

Sources of water – Impurities in water- hardness in water and its removal- steps in water purification- Aeration – Sedimentation with coagulation- filtration – chlorination -water demand for residences, restaurants, cinemas and theatres, day schools, boarding schools, hostels, hospitals with laundry, offices ,etc(per head per day) IS standards of potable water.

UNIT 4.2**WATER SUPPLY SYSTEM- (15 HRS)**

Distribution of water - continuous and intermittent water supply system
Distribution system- systems of supply-lay out of distribution system.

UNIT 4.3**PLUMBING- (40 HRS)**

History of plumbing- plumbing tools- types and sizes of pipes – pipe fittings -valves – water tap with censor- water meter- fire hydrants – pipe fixtures -pipe joining materials – method of laying pipe lines – types of pumps –hot water appliances and installation -house connection from public water supply system- lay out with estimation of plumbing system- study of rain water harvesting system.-Irrigation system for domestic farming and gardening (drip and sprinkler)

UNIT 4.4**SANITARY SYSTEM- 20 HRS**

Introduction – technical-terms –traps- different systems of sewage disposal – septic tank (different types) -lay out and estimation of sanitary system in a building

UNIT 4.5**SANITARY FIXTURES- 22 HRS**

Wash basin- showers – sink- - water closet (Indian and European type)- bidet- health faucet–flushing cistern – system of pipes-maintenance and repair of plumbing system

Module IV - Water supply and Sanitary System

Practical

1. Study of Tools, Identification and its working (6)
2. Pipe cutting with hacksaw (6)
3. Pipe threading wing Die-set (6)
4. Study of different types of fittings (L-Bow, Bend, Tee, Coupler, Reducer Coupler Union, Plug). Perform the fitting practice with the above mentioned fitting in the lab. (10)
5. Prepare the arrangement shown in given fig with necessary fittings and fix it to a wall with clamps and screws (2 Nos.) (12)
6. Fixing of pipe fittings with pipes using Treaded connection, Shelac and Cotton, Taflon tape and solvent cement (12)
7. Make a flanged joint connection using GI Flanged pipes of convenient diameter (10)
8. Practicing water tap connection in a water line (10)
9. Practicing parallel connections of three water taps in a main water supply line (16)
10. Practice shower fitting with stop cock (valve) (10)
11. Making a house water connection from a public water supply line with water meter fitting. (20)
12. Practice a drip irrigation connection for domestic purpose and small scale farming (20)
13. Draw a neat sketch of a layout plan of water supply system of one bedroomed residential building (2 Nos) (20)
14. Draw a neat sketch of layout plan of a rain water harvesting system for a residential building (20)
15. Practice the wash basin and kitchen sink fitting with necessary pipe fittings. (20)
16. Practice the Indian type water closet fitting with necessary fittings (20)
17. Practice the European type water closet fitting with flushing cistern and health fissat (20)

11. LEARNING OUT COMES (UNIT WISE)

MODULE- III

3.3.2 Able to calculate the rate of different items of work by calculating the quantities of ingredient materials and labour using DSR.

Will be able to manage construction and material purchase

3.3.3 Able to understand method of preparing estimates using computer.

3.4 Contract and Tender

3.4.1 Understand the terms contract and tender

Identify organizational principles

Able to know the terms

Understand the financial components related to contract

Know the statutory elements related to contract

Get an awareness on different kinds of contract

Understand the terms

Able to read and prepare work order

Understand the organizational principles

3.4.2 Know the procedure for inviting tenders and other details

Reading and filling of tenders

Preparation of tender

Awareness of latest technologies in the field of contract /tender

3.4.3 Understands contract agreement and conditions of contract

Able to know the legal provisions and rule to be followed while undertaking a contract

Understands the statutory principles

3.4.4 Know the duties and responsibilities of contractor, Engineer and client

Able to work in a team

3.4.5 Get thorough knowledge on making entries in measurement book and billing

Understands the procedure of making bills in public organisation

Preparation of muster roll

Understands the organizational regulations

3.5 Network Analysis

3.5.1 Understand network analysis and its importance

3.5.2 Capacity to prepare network diagram

Able to acquire knowledge essential in project planning and scheduling

Acquire thorough knowledge of the sequence of construction activities

Able to control different activities

3.5.3 Capacity to prepare network diagram
Identify uncertainties in activities
Help in project planning and scheduling

3.5.4 Able to distinguish between the two methods

3.5.5 Able to manage construction sites safely

3.6 Valuation of buildings

3.6.1 Understand valuation and its purposes, Analyze the factors which affects value of a project

3.6.2 Get thorough knowledge on various methods of valuation
Able to perform valuation

3.6.3 Know the terms
Understands rent fixation

MODULE - IV

The learners;

Unit 4;1 SOURCES AND TREATMENT OF WATER

- 4.1.1 Under stand quality of water& water
- 4.1.2 Difference between hard and soft water
- 4.1.3 Understand methods of water purification.
- 4.1.4 control the quality of water& demand of water for various premises.

UNIT 4;2 WATER SUPPLY SYSTEM

- 4.2.1 Aware the requirement of a good distribution system , its working and arrangements of Pipes in the system
- 4.2.2 prepare Lay out of the purification system.
- 4.2.3 Aware the different type of distribution system.

UNIT 4:3 PLUMBING

- 4.3.1 Understands the importance of plumbing system
- 4.3.2 Select the appropriate tool for particular the plumbing work
- 4.3.3 select different pipes based on different aspects for a plumbing work.
- 4.3.4 Select different pipe fitting , according to the necessity
- 4.3.5 Aware the need and working of water meter, its location in a lay out , etc.
- 4.3.6 know the location need of fire hydrant in buildings.
- 4.3.7 select fixtures for plumbing works
- 4.3.8 select the appropriate material for joining of pipes
- 4.3.9 develop skill in aligning pipe line with its accessories
- 4.3.10 Select pumps according to situation
- 4.3.11 develop skill in making connection with necessary fittings to tap water from public water connection
- 4.3.12 Skill in fitting hot water appliance in plumbing system.
- 4.3.13prepare layout of water supply system to new buildings / proposed with estimate
- 4.3.13 understand the rain water harvesting tank and fix it at appropriate location in buildings
- 4.3.15 Skill in irrigation works .for domestic and small scale farming or gardening

UNIT 4:4 SANITARY SYSTEM

- .
- 4.4.1 Aware the technical terms in sanitary system.

- 4.4.2 understand the objective of traps in sanitary system
- 4.4.3 Select the suitable to type of sewage disposal.
- 4.4.4 connection to public sewer adopted for a particular situation
- 4.4.5 Draft & design septic tank for different requirements. and types of plumbing system in buildings..
-
- 4.4.6 Select fix proper sanitary pipes and fittings fixtures
- 4.4.7 prepare the lay out with estimate sanitary system.

UNIT 4:5 SANITARY FIXTURES

- 4.5.1 Fix wash basin with its accessories at the appropriate location in a building

4.5.2 Fix sink with its accessories at the appropriate location in a Building

- 4.5.3 Fix shower with its accessories at the appropriate location in a building
- 4.5.4 Fix Bidet with its accessories at the appropriate location in a building
- 4.5.6 Fix flushing cistern with its accessories at the appropriate location in a building
- 4.5.7 Fix wash basin with its accessories at the appropriate location in a building
- 4.5.8 Fix health faucet with its accessories at the appropriate location in a building
- 4.5.9 Identify troubles in plumbing system and rectify it

12.SCHEME OF WORK

Month	Name of Unit		Periods	
	Theory	Practical	T	P
June	1. Introduction to quantity survey	1. Plinth area calculation 2. Measurement Practice	24	25 35
July	2.Types of Estimates	3. Quantity Survey 4.Estimation (Long wall Short wall method)	25	38 20
August	3.Analysis of rates	4.Estimation (Long wall Short wall method) 5. Estimation (Centre line method)	15	20 30
September	4.Contract & tenders 5.Network Analysis	6.Estimation (Centre line method)	10 10	50
October	6.Valuation of Buildings	6.Estimation (Centre line method)	18	20
November	7..Sources and Treatment Of Water 8.Water Supply Systems	8.Introduction to plumbing Tools 9.Cutting and Threading Of Pipes	20	50
December	Plumbing	10.practicing pipe fixtures	15	55

January	Plumbing	11.Practicing Sanitary Fittings	25	55
February	Sanitary system	12.Practicing plumbing of Buildings	20	40
March	Sanitary Fixtures, Maintenance and Repairs of Plumbing System.	12. Practicing plumbing of Buildings	22	38
Total			204	476

Grand Total 680periods

13. STRUCTURE OF MODULE III

Unit No	Unit Name	Periods
1	Introduction to Quantity survey	24
2	Types of estimates	25
3	Analysis of rates	15
4	Contract and tenders	10
5	Network analysis	10
6	Valuation of buildings	18

14. STRUCTURE OF MODULE IV

UNIT NO	UNIT NAME	PERIODS
4.1	SOURCES & TREATMENT OF WATER	5
4.2	WATER SUPPLY SYSTEMS	15
4.3	PLUMBING	40
4.4	SANITARY SYSTEM	20
4.5	SANITARY FIXTURES , MAINTENANCE AND REPAIR OF PLUMBING WORKS	22

15. CLASS ROOM ACTIVITIES

1. General discussion
2. Group discussion
3. Assignment
4. Collection of albums
5. Collection of samples
6. Activity log
7. Identification test
8. Field visit diary
9. Class test
10. Oral test
11. Seminar
12. Debate
13. Group discussion
14. Chart presentation
15. Model Preparation
16. Collection of journal reports
17. Presentation of reports of channel programme related to the topic
18. Viva
19. Brain storming project
20. Role play

16. PRACTICAL ACTIVITIES

MODULE III

Plinth area calculation:(25 periods)

- Prepare the plan, elevation and section of a two storied residential building and find out the plinth area.

Measurement Practice:(35 periods)

- Measure the dimensions of a compound wall.
- Measure the dimensions of a single room and prepare the sketch (Inner and outer dimensions)
- Measure the dimensions of all components of a residential building and prepare the line sketch.

Quantity survey:(38 Periods)

Calculation of quantities of following items of work by measuring the dimensions of an existing building/ building under construction.

- Earth work in Excavation for foundation
- RR Masonry for foundation and basement
- Masonry for super structure
- RCC works
- Plastering
- Floor finishing works

Estimation (Long wall Short wall method (40 Periods)

- Estimation of quantities of items of a compound wall.
- Estimation of quantities of items of a single room.
- Estimation of quantities of items of a residential building.
- Estimation of quantities of items of a school building.

Estimation (Centre line method):(100 Periods)

- Preparation of detailed estimate using given centre line plan.
- Preparation of detailed estimate using centre line method for a given plan.

- **Project:** Prepare the plan, section and elevation of a residential detailed estimate.

Module IV - Water supply and Sanitary System

<u>Practicals</u>	<u>periods</u>
1. Study of Tools, Identification and its working	(6)
2. Pipe cutting with hacksaw	(6)
3. Pipe threading wing Die-set	(6)
4. Study of different types of fittings (L-Bow, Bend, Tee, Coupler, Reducer Coupler Union, Plug). Perform the fitting practice with the above mentioned fitting in the lab.	(10)
5. Prepare the arrangement shown in given fig with necessary fittings and fix it to a wall with clamps and screws (2 Nos.)	(12)
6. Fixing of pipe fittings with pipes using Treaded connection, Shelac and Cotton, Taflon tape and solvent cement	(12)
7. Make a flanged joint connection using GI Flanged pipes of convenient diameter	(10)
8. Practicing water tap connection in a water line	(10)
9. Practicing parallel connections of three water taps in a main water supply line	(16)
10. Practice shower fitting with stop cock (valve)	(10)
11. Making a house water connection from a public water supply line with water meter fitting.	(20)
12. Practice a drip irrigation connection for domestic purpose and small scale farming	(20)
13. Draw a neat sketch of a layout plan of water supply system of one bedroomed residential building (2 Nos)	(20)
14. Draw a neat sketch of layout plan of a rain water harvesting system for a residential building	(20)
15. Practice the wash basin and kitchen sink fitting with necessary pipe fittings.	(20)
16. Practice the Indian type water closet fitting with necessary fittings	(20)
17. Practice the European type water closet fitting with flushing cistern and health fissat	(20)

17. OVERVIEW OF MODULE-3

This module covers the various aspects of estimating quantities of items of work involved in buildings and building services. Estimate is the calculation of quantities of different items of engineering works so as to know its approximate cost and the quantities of materials required, with the labor involved for its satisfactory completion, before the commencement of the project. This module also covers the Rate Analysis and Valuation of properties. At the end of the module the student shall be able to estimate the material quantities, make specification and prepare tender documents.

This module will fulfill the needs of the students willing to learn activities relating to the construction management/building construction sector. The students will be able to obtain jobs in quantity survey sector and those who are willing to start an enterprise on construction sector can acquire the described competencies with the help of this curriculum.

UNIT 3.1 - INTRODUCTION TO QUANTITY SURVEY

ABOUT THE UNIT

This unit gives an introduction to quantity survey. It deals with purposes of Estimation, data required to prepare an estimate, units and mode of measurement of various items of work. This unit also covers different types of areas like plinth area, floor area, carpet area, and circulation area. Specifications and detailed specifications of various items of building works is also described in this unit. Preliminary knowledge regarding quantity survey can be obtained after completion of this unit.

UNIT GRID

UNIT 3.1 - INTRODUCTION TO QUANTITY SURVEY

Unit Overview: The Student will be able to understand the need of estimation and its requirements

Ideas/Concepts/Skills	Learning outcomes	Suggested activities	Assessment
3.1.1 Purpose of Estimation, Data required to prepare Skill: Analysis, Identification	<ul style="list-style-type: none"> • Identify the need of Estimation, get a thorough knowledge of data required for estimation 	<ul style="list-style-type: none"> - Brain storming and general discussion, presentation of chart, presentation of estimates 	Activity log, oral test
3.1.2 Standard units of measurements, modes of measurements as per IS 1200 for each items of work. Skill: Analysis, comparison, identification	<ul style="list-style-type: none"> • Identify the units of measurement of various items of work • Get thorough knowledge on the methods of measurement of various items of work • Compare the difference in mode of measurement between various construction activities 	<ul style="list-style-type: none"> - Demonstration of charts - Multimedia presentation - Classroom demonstration - Practical activity 	Record of practical activities
3.1.3 Types of area:- Plinth area, Floor area, Carpet area and Circulation area Skill: Identification, Understanding, Comparison and Calculation	<ul style="list-style-type: none"> • Compare different types of horizontal areas of a building Understand the terms relevant to the construction project • Calculation of the areas • Able to apply the knowledge in construction related 	<ul style="list-style-type: none"> - Demonstration of sketches - Practical activity - Multimedia presentation 	Assignment, record of practical activities

	activities		
<p>3.1.4 Specification:- Necessity of specification, General specification of I Class building</p> <p>Detailed specifications: Earthwork in Excavation of foundation trenches, Cement Concrete, RCC, I class brickwork, RRM, Plastering</p> <p>Skill: Understanding, apply knowledge, develop construction methodologies, Execution, Management, Administration</p>	<ul style="list-style-type: none"> • Get an awareness on necessity of specification and how it affects the cost of construction • Get a thorough knowledge of detailed specifications of items of work • Understand the steps involved in an item of work • Execute various construction activities • Manage and administer material allocation 	<p>- Seminar, General discussion, Field visit</p>	<p>Seminar report and Field visit report</p>

ASSESSMENT ACTIVITY :

Preparation of a chart on data required to prepare an estimate and an oral test based on purposes of estimation

PORTFOLIO ITEMS:

Chart showing the data needed for estimation.

ASSESSMENT ACTIVITY :

Practical activity on measurement of various items of work

PORTFOLIO ITEMS:

Record of the practical activity

ASSESSMENT ACTIVITY:

Practical activity on measuring various types of areas

PORTFOLIO ITEMS:

Practical Record

- **ASSESSMENT ACTIVITY:**
- **Preparation of field visit report after thorough inspection of specifications of various items in construction sites**
- **PORTFOLIO ITEMS:**
- **Field visit report**

UNIT 3.2 – TYPES OF ESTIMATE

ABOUT THE UNIT

This unit deals with two methods of estimation of quantities of various items of work which helps to prepare the detailed estimate of a building. It also includes preparation of rough estimates & bar bending schedule for calculation of actual quantities of steel.

Ideas/Concepts/Skills	Learning outcomes	Suggested activities	Assessment
3.2.1 - Types of estimate:- Preliminary or approximate estimate, Plinth area estimate, Cubical content estimate, Detailed estimate Skills: Comparison, Selection, Reasoning, Decision making, computation	Know different types of estimate prepare rough estimates Make feasibility studies of projects Select appropriate method of estimation	Multimedia demonstration Class room exercises on preparation of rough estimates	Verification of classroom exercise Class test
3.2.2 - Different methods of estimation Long wall short wall method - simple exercises Centre line method Skill : Analysis, Reasoning Tabulation & Calculation	Able to understand methods of estimation Compute the quantities of different items of work and calculate the estimated cost Prepare detailed estimates of residential buildings	Computation of quantities using given sketches Preparation of detailed estimate OJT	Verification of Estimates Prepared by the students OJT report

<p>3.2.3 - Bar bending Schedule Skill: Analysis, Imagination, Tabulation & Calculation, Drawing</p>	<p>Prepare bar bending Schedule of small items Able to calculate quantity of steel Create technical sketches</p>	<p>General discussion with the help of sketches Field visit to construction sites Demonstration of bar bending schedule already prepared OJT Simple exercises</p>	<p>Class test Field visit report OJT report Verification of bar bending schedule prepared by the students</p>
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Additional information:

In the absence of plan of a building or only a line plan is drawn, the plinth area can be found out from the floor area. For this add the area of walls at the rate of 15% to 18% (but 8% for RCC framed structures) to the floor area.

ASSESSMENT ACTIVITY :

Class room exercises of estimation by plinth area method and cubical content method.

PORTFOLIO ITEMS:

Results of class room exercise.

Additional information:

For making the concept clear, draw the plan of foundation trench, foundation concrete and the plan of each footing or steps of wall ; and find out lengths of long walls and short walls.

ASSESSMENT ACTIVITY :

Class room exercises of finding quantities by long wall short wall method after preparing plans at various levels of a building.

PORTFOLIO ITEMS:

Results of class room exercise.

ASSESSMENT ACTIVITY :

Class room exercises of preparation of detailed estimate by centre line method.

PORTFOLIO ITEMS:

Results of class room exercise.

ASSESSMENT ACTIVITY :

Class room exercises on finding the length of bars and prepare the bar

Bending schedule and a field visit to study bar bending.

PORTFOLIO ITEMS:

Results of class room exercise and field visit report.

Unit 3.3: ANALYSIS OF RATES

ABOUT THE UNIT

The analysis of rates deals with the calculation of quantities of materials and labour required per unit quantity, required for each item of work and thereby finding out the rates of various items of construction activities. This is done with the help of DSR. This is essential for estimating cost of construction. The study of analysis of rates will also help in procurement of materials in construction projects.

Ideas/Concepts/Skills	Learning outcomes	Suggested activities	Assessment
3.3.1 – Factors affecting cost of an item of work, Schedule of rates Skill: Analysis, Reasoning and Application	Analyse the factors which affect the cost of an item of work Able to identify how cost of construction can be reduced Able to read data book and familiarise Schedule of rates	Brain storming and class room interaction Market survey Demonstration of Data book	Participation Report of Market Survey Class test Oral test
3.3.2 –Analysis of rates of different items of work – Earthwork excavation in ordinary soil Earthwork Excavation in hard soil PCC Works RCC work of different proportions RR masonry Brick masonry Skill: Analysis, Observation, Calculation and Comparison.	Able to calculate the rate of different items of work by calculating the quantities of ingredient materials and labour using DSR. Will be able to manage construction and material purchase	Class room exercises	Activity log Assignment
3.3.3 Analysis of rates and preparation of abstract of cost using electronic spreadsheets.	Able to understand method of preparing estimates using computer.	Practical	Verification

ASSESSMENT ACTIVITY :

Class test on purposes of rate analysis, Factors affecting cost of an item of work and schedule of rates.

PORTFOLIO ITEMS:

Answer sheets of class test.

ASSESSMENT ACTIVITY :

Preparation of rate analysis of different items of work using DSR

PORTFOLIO ITEMS.

Results of rate analysis prepared .

Unit 3.4: CONTRACTS & TENDERS

ABOUT THE UNIT

This unit deals with the terms and procedures adopted in awarding public works. This familiarises the terms contract, tender etc. and also gives an introduction to the financial components related to contracts. This unit also describes the legal provisions to be followed while undertaking a contract, the duties and responsibilities of an Engineer, contractor and client. The billing procedures in public works like measurement book, muster roll etc. are also included in this unit. This also gives an introduction to e – tender; the latest mode of awarding tender.

Ideas/Concepts/Skills	Learning outcomes	Suggested activities	Assessment
3.4.1 -Definition of contract and tender, Earnest money and Security deposit, Kinds of contract, Work order form, Administrative approval and technical approval Skill: Analysis, Management, Administration	Understand the terms contract and tender Identify organisational principles Able to know the terms Understand the financial components related to contract Know the statutory elements related to contract Get an awareness on different kinds of contract Understand the terms Able to read and prepare work order Understand the organisational principles	General discussion Demonstration of copies of contract and tender Class room discussion Face to face sessions with PWD engineers Preparation of chart and Discussion Field visit to PWD office Demonstration of work order form General discussion Expert Sessions	Activity log Oral test Participation in activities Class test Field visit report
3.4.2 Procedure for inviting tenders, Invitation of tenders, E - tender Skill: Technology up gradation, Administration	Know the procedure for inviting tenders and other details Reading and filling of tenders Preparation of tender Awareness of latest technologies in the field of contract /tender	General discussion Collection of tender notices from news papers field visit Multimedia presentation Expert class	Verification of collected samples Field visit report OJT report Activity log

		OJT	OJT report Class test
3.4.3 - Contract agreement and conditions of contract Skill: Management, Analysing	Understands contract agreement and conditions of contract Able to know the legal provisions and rule to be followed while undertaking a contract Understands the statutory principles	Demonstration of contract agreement Interaction with contractor/engineer	Participation Oral test
3.4.4 - Obligations of contractor engineer and client Skill: Organisation skill	Know the duties and responsibilities of contractor, Engineer and client Able to work in a team	Experience sharing with Contractors & Engineers Role play	Participation Activity log
3.4.5 - Measurement book, Muster roll Skill: Tabulation, computation, administrative skill	Get thorough knowledge on making entries in measurement book and billing Understands the procedure of making bills in public organisation Preparation of muster roll Understands the organisational regulations	Demonstration of M-book format and discussion Field visit Demonstration of muster roll Preparation of muster rolls, OJT	Field visit report OJT report Computation Evaluation of muster roll prepared

ASSESSMENT ACTIVITY :

Preparation of chart showing different types of contract and an oral test on the terms contract, tender etc.

PORTFOLIO ITEMS

Chart showing different types of contract.

Additional information:

The M – book format, details of writing up of M-book, issue of M-book, test checking of measurements etc. can be transacted in detail.

Additional information:

Transact the idea by demonstration of muster roll format and mentioning the rules to be followed while writing muster roll so that the learner gets the ability to prepare the muster roll.

ASSESSMENT ACTIVITY:

- 1. Preparation of bills giving details of works in MB format .**
- 2. Preparation of muster roll, giving the details.**
- 3. Class test on invitation of tender, conditions of contract and E-tender**

PORTFOLIO ITEMS

Bill and Muster roll prepared in the format .

ASSESSMENT ACTIVITY :

- 1 Judge the active participation in the expert session with the Engineer and Contractor.**
- 2. Judge the active participation it role play on duties of engineer, contractor and client.**

PORTFOLIO ITEMS.

Short notes prepared after the interaction with engineers and contractors .

Unit 3.5: NETWORK ANALYSIS

ABOUT THE UNIT.

This unit deals with scheduling of civil works by managing time and cost effectively through construction project planning techniques like CPM and PERT. This also deals with safety measures in construction sites.

Ideas / Concepts / Skills	Learning out Comes	Suggested activities	Assessment
3.5.1 - Introduction Skill: Understanding	Understand network analysis and its importance	General discussion	Oral test
3.5.2 - Developing a network using CPM Skills: Planning, Scheduling, Reasoning and Controlling	Capacity to prepare network diagram Able to acquire knowledge essential in project planning and scheduling Acquire thorough knowledge of the sequence of construction activities Able to control different activities	Preparation of network, diagram using CPM	Verification of CPM diagram
3.5.3 - Developing a network Using PERT Skills: Planning	Capacity to prepare network diagram Identify uncertainties in activities Help in project planning and scheduling	Preparation of network diagram using PERT	Verification of PERT diagram

3.5.4 Difference between PERT and CPM Skill: Identification, Comparison	Able to distinguish between the two methods	General discussion	Class test
3.5.5 Construction safety management: Importance of construction safety, safety measures Skill: Management, Administration	Able to manage construction sites safely	General discussion	Class test Activity log

ASSESSMENT ACTIVITY :

Conduct a class test on terms used in network analysis.

PORTFOLIO ITEMS

Answer sheet of class test .

ASSESSMENT ACTIVITY :

Exercises on preparing network diagram using CPM method with the given details.

PORTFOLIO ITEMS

CPM charts .

ASSESSMENT ACTIVITY :

Exercises on preparing network diagram using PERT method with the given details.

PORTFOLIO ITEMS

Net work charts prepared using PERT method .

ASSESSMENT ACTIVITY :

Conduct a seminar on importance of construction safety and safety measures.

PORTFOLIO ITEMS

Seminar report .

Unit 3.6: VALUATION OF BUILDING

ABOUT THE UNIT

This unit deals with the method of valuation of buildings for different purposes like sale, availability, housing loans from financial institutions, acquisition by government agencies, etc. This chapter explains methods like sinking fund method, depreciation method etc. for evaluation of a building arithmetically.

Ideas / Concepts / Skills	Learning out Comes	Suggested activities	Assessment
3.6.1 – Valuation and purposes of valuation, Factors affecting value of a property Skill: Identification, Analysing, Reasoning	Understand valuation and its purposes, Analyse the factors which affects value of a project	Classroom discussion Group discussion	Activity log Presentation of report
3.6.2 Methods of valuation: Valuation based on cost, valuation based on profit, depreciation method, Sinking fund method and quantity survey method Skill: Assessment, valuation, comparison	Get thorough knowledge on various methods of valuation Able to perform valuation	General discussion Practical activity Problem solving	Report of practical activity Verification of solution of problem
3.6.3 Mortgage and Annuity, Rent fixation Skill: Analysis	Know the terms Understands rent fixation	General discussion Case study	Activity log Oral test

Assesment Activities

Class test, Oral test, Exercises on Rent Fixation

Portfolio

Answer scripts, Lecture Notes,

22. OVERVIEW OF MODULE IV

To meet the needs of fast changes in the present day construction industry it is essential to develop the skills and techniques to match the techniques in the ever growing industry. In view of the above the curriculum in water supply and sanitary arrangements module has been designed and developed.

Among all building services to be provided in a building be it a residential or public building ,water supply and sanitary arrangements are the most essential services and well trained members with necessary skill sets are in great demand to attend the minor to major jobs in the buildings. This course provides the student about technique and the knowledge of plumbing systems in the building in addition to latest technology developed in rural water supply. and sanitation, solar heaters hot water installations. After the successful completion of the module the learner will be capable of preparing the lay out plan of water supply as well as sanitary works of public and domestic systems, execute plumbing works and its repair.

23. UNIT 4-1

SOURCE AND PURIFICATION OF WATER

This unit covers the selection of source of water, the impurities in water, its purification, removal of hardness in water. It discusses the different methods of purification of water, the per capita demand of water for different types of premises etc.

UNIT GRID

Unit 4-1 SOURCES & TREATMENT OF WATER

Units	Ideas/concept/skill	Learning out comes THE LEARNER WILL BE ABLE TO	Suggested activity	Assessment
4.1	Sources of water, impurities in water Skill: Identification	4.1.1 Understand quality of water &	demonstration with chart	Class test
4.1	Hardness in water and its removal. Skill: Constructing knowledge	4.1.2 Differentiate between hard and soft water	General discussion.	Chart preparation
4.1.	Different steps in water purification Aeration , sedimentation with coagulation, filtration, chlorination. Is standards of potable water per capita consumption of water, Water demand for residences, restaurants, hostels, hotels etc. Skill: Comparison skill, Charting. Observing, Demonstrating.	4.1.3 Understands methods of water purification, 4.1.4 control the quality of water, 4.1.5 Demand of water for various premises.	Field visit to water Treatment plant, demonstration with ICT and sample test. Discussion with chart.	Field report, oral test, survey report

UNIT 4-3

PLUMBING

This unit deals with the different types and sizes of pipes and tools used in plumbing systems, , fixtures, fittings, methods of laying pipelines, types of pumps, connection to public water supply systems, estimation of plumbing layouts, installation of hot water appliances, rainwater harvesting systems, irrigation systems for small scale or domestic farming and gardening.

UNIT GRID

Unit	Concept/ Ideas/ Skills	Learning outcomes THE LEARNER WILL BE ABLE TO	Activities	Assessment
4.3	History of Plumbing	4.3.1 Understands the importance of plumbing	Discussion	Oral test
4.3.	Plumbing tools ,uses of tools. (Guiding & testings tools. Making tools ,holding tools, Scrapping and Guiding tools, Boring and threading tools, striking & fastening tools) Skill: Identification selection	4.3.2 Select the appropriate tool for particular the plumbing work	Demonstrati on with actuals, field visit to shops.	Oral test , Identification test

4.3.	<p>Type & sizes of pipes According to material used – mild steel, Cast iron, Copper, Brass, Lead, Plastic, Glass, AC sheet According to process of manufacture- Braze, Butted, Flanged, Riveted, Soldered, According to Kind of joint- Threaded flanged, spikelet According to strength standard heavy- Extra heavy.</p> <p>Skill: Identification, selection, Analyzing.</p>	4,3,4 Select appropriate type and size of pipe for plumbing work.	Demonstration with actual and discussion .	Identification, sketch, Discussion note.
4.3.	<p>Types of pipe fittings Water Meter Fire hydrants</p> <p>Skill: Identification, selection, Analyzing.</p>	4.3.4 select the appropriate pipe fittings, 4,3,5 know the location & need of water meter 4.3.6 fire hydrant in buildings	Discussion with actual, Lay out plan. Field visit	Lab practice Identification test
4.3.	<p>Pipe fixtures Skill: Identification, selection, Analyzing</p>	4.3.7 select fixtures for plumbing works	Field visit discussion with sketch	Lab practice
4.3.	<p>Joining Materials, Method of laying pipe lines, Types of pumps, Skill: selection, Analyzing, constructing knowledge.</p>	4,3,8 select the appropriate material for joining of pipes 4.3.9 develop skill in aligning pipe line with its accessories 4.3.10 Select pumps according to situation	Assignment, market survey. Lab practice & discussion Market survey, Field survey or discussion with sketch.	Survey report, oral test Performance in lab practice, Preparation of drawing. Field note, class test.
4.3.	<p>House connection from public water supply system. Hot water appliances and installation. Rainwater harvesting</p>	4.3.11 develop skill in making connection with necessary fittings to tap water from public water	Field visit, demonstration with sketch	Field report, class test

	systems Skill: Drawing, selecting, Handling tools and fixtures.	connection, 4.3.12 Skill in fitting hot water appliances.		
4.3.	Lay out with estimation of plumbing system Skill: Drawing, selecting, Estimating, Measuring.	4.3.13 prepare layout of plumbing system in new buildings / proposed building with estimate	Lab practices	Performance assessment by participation in lab, 'o.j.t etc
4.3.	Study of rain water harvesting system . Irrigation system for domestic farming and gardening (Drip & sprinkler irrigation) Skill: Understanding, Handling.	1.3 .14 understand the rain water harvesting tank and fix the appropriate location of tank in buildings. 1.4 .15 Skill in plumbing works for domestic farming and gardening.	Field visit, Discussion with sketch, seminar.	Field report, oral test, seminar report.

ASSESSMENT ACTIVITY

Verification of Market visit report ,Sketch of fixtures. Participation in Discussion ,oral test, viva, class test

PORTFOLIO

Market report, Drawing, Discussion note,

ASSESSMENT ACTIVITY

Verification of Market visit report ,Sketch of fixtures. Participation in Discussion ,oral test, viva, class test

PORTFOLIO

Market report, Drawing, Discussion note,

Unit 4.4

SANITARY SYSTEM'

The unit Sanitary system includes the study of technical terms in sanitary engineering, sanitary fittings and fixtures, pipes, sewage disposal and treatment and the estimate of sanitary system.

Unit	Concept/ skill/ idea	Learning outcomes THE LEARNER WILL BE ABLE TO	Activities	Assessment
4.4.	Technical terms, Traps Skill: Understanding	4.4.1 Aware the technical terms in plumbing 4.4.2 understand the objective of traps in sanitary system.	Discussion Demonstration with actual.	Oral test, preparation of Sketch, identification.
4.4.	Different types of sewage disposal , connection to public sewer, Skill: Select ion, Understanding skill	4.4.3 Select the suitable type of sewage disposal, adopted for a particular situation 4.4.4 Skill in making connection to public sewer from house	Seminar	Seminar report
4.4.	Septic tank, different types with design. Skill: Drafting, Desgning,	4.4.5 Draft & design septic tank for different requirements	Discussion with sketch/Visit to Construction site/ Market	Identfication,selecton ,Analysing. Field report sketch

		and types of sanitary system in buildings..	visit	
4.4.	Layout and estimation of sanitary system in a building. Drawing Skill: selecting, Estimating, Measuring	4.4.6 Select and fix proper sanitary pipes ,fittings, fixtures . 4.4.7 Prepare the lay out with estimate of sanitary system.	Demonstration with line diagram	Lay out plan

ASSESSMENT ACTIVITY

Class test, Verification of Assignment, Identification test

PORTFOLIO

Answer script, Activity log of site , .Assignment

ASSESSMENT ACTIVITY

Prepare lay out plan of sanitary system of different building with estimate, Lecture note verification, class test, preparation of sketches in the class room, oral test, Evaluating Activity log of O.J.T in this concept, Participation in group work .

PORTFOLIO

Lay out plan with estimation, Lecture note, Activity log of O.J.T, .Field visit

T.E QUESTIONS

- 1.Differentiate between sewer, sewage and sewerage in sanitary engineering?
- 2.What are the advantages of water carriage system over conservancy system?
3. Mention the different types of pipes in sanitary system?
4. What are the functions of trap and Antisiphonage pipe ,?
- 5.Gully traps are used in
- 6.Floor traps are used in

Unit 4.5

SANITARY FIXTURES

This unit explains the methods of fitting different fixtures like wash basins, sink, shower, water closet, health faucets, bidets, etc. with its accessories in the appropriate location of the building. The unit also deals with the various types of troubles in plumbing with its rectification methods.

4.5	SANITARY FIXTURES			
Unit	Concept/ skill/ idea	Learning outcomes	Activities	Assessment
4.5.	Wash basin Shower Sink Water closet Health faucet Flushing cistern. Maintenance and repair of plumbing system.	45.1 select & fix the wash basin, 4.5.2 sink 4.5.3, water closets 4..5.4 , shower, 4.5.5 health faucet 4.5.6 flushing cistern , 4.5.7 bidet & its accessories at the proper location in building , 4.5.8 identify the troubles and its remedies in plumbing system. .	Lab Practice, shop visit, discussion with presentations.	Performance assessment by participation in lab activities.

Assesment Activity

Perfomance in the practicals, Evaluation through viva. class test, . Field study and preparation of field reports from show rooms ,journal report collection about latest sanitary fixtures and their presentations in class room etc

Port Folio

Journal pages collection ,Field report, practical record. drawings

EXTENDED ACTIVITIES

Prepare the detailed estimate of a water supply ,sanitary and sewerage scheme to be provide in the building with the given plan?

27. ON THE JOB TRAINING CENTRES

1. Local Water Supply Authority . .
2. Sewage Board or local bodies managing sewage.
3. Pollution control board.
4. All sites works related to construction management .
5. Visit to water treatment plant.
6. Visit to sewage treatment plant.
7. Construction sites of plumbing and sanitary works.
8. Pipe manufacturing units.

EVALUATION OF O.J.T

Attendance and punctuality - 30%

Familiarisation with technician -5%

Familiarisation with tools and materials-5%

Application of knowledge -10%

Problem solving skill - 10%

Comprehension and observation -10 %

Human Relations -5%

Ability to communicate -10 %

Maintenance of diary -10%

TOTAL -100 %

The On The Job training can be done after each semester (MODULE) for one week in any one of the above centre according to the feasibility of distance from school.

28 Consumables

1. Hack saw blade
2. Nail
3. Saddle clip
4. Teflon tape
5. Cotton waste
6. Shellac
7. Solvent cement
8. PVC pipe $\frac{3}{4}$ ", 1"
9. Hot water pipe $\frac{1}{2}$ "- PVC
10. Elbow - $\frac{3}{4}$ ", $\frac{1}{2}$ "
11. Reducer - $\frac{3}{4}$ "- $\frac{1}{2}$ ", - $\frac{3}{4}$ "-1"
12. Tee - $\frac{3}{4}$ ", 1"
13. Reducer Tee - - $\frac{3}{4}$ "- $\frac{1}{2}$ ", $\frac{3}{4}$ "-1"
14. Bend
15. Plug (flanged)
16. End Cap
17. String
18. Water tap
19. Shower
20. Health faucet
21. Hand Shower
22. European type water closet
23. Indian type water closet
24. Bidet

Standard list of tools & equipments

- | | |
|------------------------------|---------|
| 1. Tape (20m) | - 5 nos |
| 2. Metallic tape | - 4 nos |
| 3. Ball pane hammer | - 1 nos |
| 4. Claw hammer | - 1 nos |
| 5. Pipe vice | - 2 nos |
| 6. Drilling machine | - 1 nos |
| 7. Hack saw frame with blade | - 5 nos |

8. Flat file	- 2 nos
9. Flat chisel	- 5 nos
10. Plier	- 2 nos
11. Screw driver	- 5 nos
12. Adjustable Spanner	- 2 nos
13. Pipe wrench	- 2 nos
14. Die set	- 3 nos
15. Spirit level	- 2 nos
16. Water meter	- 1 nos

29. LIST OF REFERENCES

MODULE -3

QUANTITY SURVEYING AND COSTING

Estimating and Costing : B .N .DUTTA

Estimating and Costing : BIRDIE

Quantity Surveying : A.K KAMALA

Quantity Surveying (Estimating and Costing) : P.L BHASIN

Estimating and Costing :R.L PEURIFOY

Estimating and Costing : SUBRAMANYAN

MODULE -4

WATER SUPPLY AND SANITARY ARRANGEMENTS IN BUILDINGS

Water Supply and Sanitary Engineering : G.S BIRDIE

Water Supply and Sanitary Engineering : RANGWALA

Water Supply treatment and disposal : MEDCAFF & GRAW

Water SUPPLY Engineering : SANTHOSH KUMAR GARG

Plumbing Design & Practice :S.G DEOLALIKAR

Water treatment &Sanitation : Simple methods for Rural areas:

H.P MANN &D.WILLIANSON

Water Supply and Sanitary Engineering: DUGGAL

Water Supply and Sanitary Engineering : V.N VAZIRANI

Environmental Engineering : BALIJEETH KAPOOR

Environmental Engineering : RAMACHANDRAIAH

IS CODES

SP35(S&t)1987: HAND BOOK OF WATER SUPPLY AND DRAINAGE WITHSPECIAL EMPHASIS ON PLUMBING BY BUREAU OF INDIAN STANDARDS.

IS 2065: 1983 CODE OF PRACTICE FOR WATER SUPPLY IN BUILDINGS BY BIS.

IS 12183(PART1) 1987 CODE OF PRACTICE FOR PLUMBING IN MULTISTOREYED BUILDINGS BY BIS.

IS 7558;1974 CODE OF PRACTICE FOR DOMESTIC HOT WATER INSTALLATIONS BY BIS.

SP7-1983 NATIONAL BUILDING CODE OF INDIA.(PART 1X- PLUMBING SERVICES) BY BIS.

SOLAR WATER HEATER (C.B.R.I) BY M.L GUPTA &SRIVASTAVA

IS1172-1993 CODE OF BASIC REQUIREMENTS FOR WATER SUPPLY ,DRAINAGE AND SANITATION(4TH EDITION) BY BIS