I

Name _____

Roll No. _____ Year 20____20____

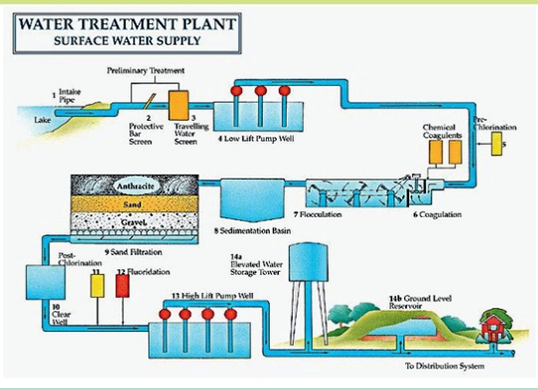
Exam Seat No. _____

CIVIL GROUP | SEMESTER - V | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

PUBLIC HEALTH ENGINEERING (22504)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

for

Public Health Engineering

(22504)

Semester – V

(CE, CR, CS)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO:9001: 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on May,2019)

Maharashtra State

Board of Technical Education

Certificate

This is to certify that Mr. / Ms. …….
Roll No…….of Fifth Semester of Diploma in ……. of Institute ……
(Code……..) has attained predefined practical outcomes (PROs) satisfactorily in course **Public Health Engineering (22504)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No……
Date:…..... Exam Seat No. …….....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curriculam for engineering diploma programs with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Public Health Engineering can play an important and significant role in solving environmental health issues. The world is facing unprecedented humanitarian needs. Today's humanitarian crisis tends to be greater in number, often in urban settings, longer in duration and broader in regional impact. They generate human sufferings on a greater scale, disrupt essential services, such as water supply or sanitation and put health of large population at risk. Engineers and technical specialists in water, sanitation, energy, environment, and in other related fields play a vital role to respond these challenges and growing needs. A first part of subject of Public health engineering includes the collection of water, purification, transmission and distribution of water. In the second part, from the source of waste water, its carriage, collection, necessary treatments for its safe disposal all are included so that study of both parts of subject ensures proper town planning considering health issues.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practicals of this Course:-

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

PO 4. Engineering tools: Apply relevant civil technologies and tools with an understanding of the limitations.

PO 8. Individual and Team Work: Function effectively as leader and team member in Diverse /multidisciplinary team

PO 10. Lifelong learning: Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.

PSO 1 Construction Planning and Designing: Perform optimal civil engineering construction, planning and designing activities of desired quality at optima cost.

PSO 2 Construction Execution and Maintenance: Execute civil engineering construction and maintenance using relevant materials and equipments

Practical- Course Outcome matrix

Course Outcomes (COs)

a Identify the sources and characteristics of water and wastewater.
b Estimate the quantity of drinking water and wastewater generated.
c Draw labeled systems of plumbing for building sanitation.
d Draw the flow diagram for process of treatment of water and wastewater.
e Identify various accessories for efficient conveyance and distribution of water.

S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.
1	To determine pH value of given sample of water.	√	–	–	–	–
2	To determine the turbidity of the given sample of water.	√	–	–	–	–
3	To determine residual chlorine in a given sample of water.	√	–	–	–	–
4	To determine suspended solids dissolved solids and total solids of given sample of water.	√	–	–	–	–
5	To determine the dissolved oxygen in a sample of water	√	–	–	–	–
6	To undertake a field visit to water treatment plant.	–	–	–	√	–
7	To determine the optimum dose of coagulant in the given raw water sample by jar test.	–	–	–	√	–
8	To draw sketches of various valves used in water supply pipe line	–	–	–	–	√
9	To draw a sketch of one pipe and two pipe system of plumbing	–	–	√	–	–
10	To determine B.O.D. of given sample of waste water.	√	–	–	–	–
11	To determine pH value of given sample of wastewater.	√	–	–	–	–
12	To determine suspended solids dissolved solids and total solids of given sample of wastewater.	√	–	–	–	–
13	To determine the dissolved oxygen in a sample of wastewater.	√	–	–	–	–
14	To determine C.O.D. of given sample of waste water.	√	–	–	–	–
15	To Prepare a report of a field visit to wastewater treatment plant	–	–	–	√	–
16	To prepare a report of a field visit to bio gas /gobar gas plant in your locality	–	–	–	√	–

List of Industry Relevant Skills

The following industry relevant skill of the competency **'Determination of characteristics of water and wastewater for domestic or industrial purpose'** are expected to be developed in you by undertaking the practical's of this laboratory manual.

a. Determination of characteristics of water and wastewater.
b. Execute various the tests on water and waste water of different sources.
c. Interpret the results of test performed stating the limiting values of various parameters.
d. Suggest suitable method for water and waste water treatment depending upon the test results obtained.

Brief Guidelines to Teachers

Hints regarding strategies to be used:

1. For difficult practical if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
2. Teachers should give opportunity to students for hands-on after the demonstration.
3. Teacher should give relevant information (including safety measures) to students prior to visit arranged for effective utilization of time and understanding.
4. Teachers shall ensure that required equipment are in working condition before start of each experiment, also keep operating instruction manual available.
5. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practicals.
6. Assess the skill achievement of the students and COs of each unit.
7. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question banks for each course.
8. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can incorporate in Appendix.
9. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read the complete write-up of that practical sheet.
10. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
11. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines.
12. Teacher should ensure that the different types of water samples should be available in the laboratory.
13. Teacher should distribute all the questions among all the three batches so as to attempt all questions. It is recommended that every year the combination of questions must be changed for each batch.

Instructions for Students

1. For effective implementation and attainment of practical outcomes, in the beginning it-self of each practical, students should go through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
2. Student ought to refer the data books, IS codes, safety norms, internet websites etc.
3. Student should not hesitate to ask any difficulties that he/she face during the conduct of practicals/visits.
4. Student should develop the habit of pear discussions/group discussion related to the experiment/exercise so that exchange of knowledge /skills could take place.
5. Student shall attempt to develop related hands-on skills and gain confidence.
6. Students shall visit the nearby construction site, technical exhibitions, trade fair etc. even it is not included in the lab manual.
7. Students should develop the habit of self-learning techniques rather than remaining dependent totally on teachers.
8. Student should develop habit to submit the practical exercise continuously and progressively on the scheduled dates and should get the assessment done.
9. It is necessary to take all type of precautionary measures by students during site visit.
10. Students should take photographs with prior permission (which may be different for each student) on their own for deep understanding of the concepts and same should be attached (pasted in separate sheet) in respective practical/visit.

Content Page

List of Practicals and Progressive Assessment Sheet

Name of the Student- _____ Roll No. _____

Sr. No	Title of the Practical	Page No.	Date of Performance	Date of Submission	Assessment Marks (25)	Sign. of Teacher	Remarks (If Any)
1.*	To determine pH value of given sample of water.	1					
2.*	To determine the turbidity of the given sample of water.	9					
3.	To determine residual chlorine in a given sample of water.	17					
4.	To determine suspended solids dissolved solids and total solids of given sample of water.	25					
5.*	To determine the dissolved oxygen in a sample of water.	33					
6.*	To undertake a field visit to water treatment plant.	41					
7.*	To determine the optimum dose of coagulant in the given raw water sample by jar test.	49					
8.	To draw sketches of various valves used in water supply pipe line	57					
9.	To draw a sketch of one pipe and two pipe system of plumbing	61					
10.	To determine B.O.D. of given sample of waste water.	69					
11.*	To determine pH value of given sample of wastewater.	80					
12.	To determine suspended solids dissolved solids and total solids of given sample of wastewater.	89					
13.*	To determine the dissolved oxygen in a sample of wastewater.	98					
14.	To determine C.O.D. of given sample of waste water.	106					
15.*	To Prepare a report of a field visit to wastewater treatment plant	115					
16.	To prepare a report of a field visit to bio gas /gobar gas plant in your locality	122					

Note: A judicial mix of minimum 12 or more practical need to be performed , out of which practicals marked as * are compulsory.

Note: To be transferred to Proforma of CIAAN-2017.

Practical No. 1: pH Value of Water

I. Practical Significance

Determination of pH is one of the important objectives considered in evaluation of quality of water source to be used for drinking water supply. The pH level of water measures how acidic it is (pH stands for potential hydrogen, referring to how much hydrogen is mixed with the water.) 7 is a balanced pH for water. pH is important in various treatment processes of water i.e. coagulation and chlorination. It is also important for corrosion control, removal of Iron and Manganese as well in softening of water.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and wastewater.

IV. Practical Outcome:

To determine pH value of given sample of water.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of (pH) quality of water for domestic and industrial water supply."**

a. Determination of pH value of given sample of water
b. Comparing two water sources based on their pH value.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.

c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

pH value shows the potential of hydrogen ion concentration present in water sample. The term pH refers to the measure of hydrogen ion concentration in a solution and defined as the negative log of H^+ ions concentration in water. It is an indicator of acidity and alkalinity of water sample. The value of pH is inversely proportional to the temperature.

$pH = - \log (H^+)$

Where H^+ is the concentration of hydrogen ions in moles per liter of water.

The value of pH, 0 to little less than 7 are termed as acidic and values of pH little above 7 to 14 are termed as alkaline. When the concentration of H^+ and OH^- are equal then it is termed as neutral (pH =7)

Acceptable limit of pH for drinking water is 6.5 to 8.5 as per WHO. For pH values greater than pH 10, the rusting rate seems to fall as pH is increased. Low pH value will cause acidosis of kidneys and lungs.

VIII. Experimental Set-up

Figure 1: Digital pH meter.

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Digital pH meter	4 Digit display (LED), 0 to 1000 mV, Resolution: 0.01 pH manual temp., compensation : 0 to 80 ˚C	1 No.	Per batch
2.	Beaker	Standard glassware beaker of 500 ml. capacity	3 Nos.	Per batch

X. Procedure

1. **Preparation of Buffer solution**.
   - Take 100 ml of distilled water in a beaker.
   - Put the buffer tablet in the distilled water.
   - Disperse the buffer tablet in the distilled water by continuously stirring action.
   - Prepare the buffer solution of pH 4.0, 7.0 and 9.2

2. **Calibration of the instrument.**

   The instrument should be calibrated before beginning the measurement
   - First rinse the electrode with distilled water and dries its bulb by using tissue paper.
   - Dip the electrode in a buffer solution of pH 7.
   - Set the temperature (˚C) control to the room temperature.
   - Set the function selector to pH position and adjust the CALIBRATE control until the meter displays the precise pH of buffer solution.
   - Now the set the function selector switched to STAND BY position.
   - Remove the electrode from buffer solution. Wash it with distilled water and wipe out with tissue paper. Repeat the above procedure for calibration with buffer solution of 4.0 and 9.2 pH values.

3. **Operation of Instrument**
   - Calibrate the pH meter with two standard buffer solutions as per the above procedure.
   - Clean and rinse the electrode thoroughly with distilled water and carefully wipe with tissue paper.
   - Dip the electrode into the sample of solution. Stir the solution by keeping on magnetic stirrer or stir it manually.
   - Wait up to 1 minute for steady reading +0.1 pH units.
   - Record reading in steady condition after one minute.

XI. Precautions to be followed

1. Use clean and dry beakers.
2. The Standardization of pH meter is essential before use.
3. Clean and wipe out electrode every time of immersion.
4. Record the temperature of room.
5. Record reading in steady condition.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
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4					

XIV. Precautions followed

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XV. Observations

Sr. No.	Particulars	Sample No.		Average value of pH of water
	Type of Sample	1	2	
1	Tap water (Treated water)			
2	Bore Well water			
3	Surface water (Lake, River etc.)			

Sample Calculation

For Observation No.…….

Average pH = pH (1) +pH (2) /2 = ……..

Average pH of Tap water =……

Average pH of Bore Well water =……

Average pH of surface water =……

XVI. Results

The pH value of untreated or raw water is observed as …….. .

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the location of bore well and surface water sample.
2. Give the reason of variation in pH due to temperature.
3. Justify the difference in pH values of above samples.
4. State the acceptable limit of pH value for drinking water.
5. Suggest the treatment for pH to obtain it in acceptable limit.
6. State how pH value will affect on the other treatment processes of purification.
7. Write effects of water having pH less or more than limiting value on distribution network and human being.
8. Comment on seasonal variation in pH value of surface and subsurface water.
9. Suggest chemicals used for adjustment of pH of water.
10. State the importance of pH value of water to be used in industrial use.

Space to Write Answers

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XX. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Preparation of buffer solution	20 %
2	Calibration of the instrument	20 %
3	Recording of observations	20 %
Product related:10 Marks		**40%**
3	Interpretation and Conclusion	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 2: Turbidity of Water

I. Practical Significance

Turbidity is the degree to which a transparent liquid scatters light, usually a measure of the amount of suspended material in the liquid. Even after settlement of heavy particles, small tiny particles remain in suspension and water appears turbid. These suspended solid and colloidal particles cause *turbidity* in water. Turbid water can indicate the presence of high bacteria levels, pathogens, or particles that can shelter harmful organisms. To decide quantum of further treatments i.e. chemical coagulation, clariflocculation, filtration, disinfection; turbidity of water is important. Therefore water treatment plants constantly monitor turbidity levels to ensure that the water does not exceed permissible limit.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and wastewater.

IV. Practical Outcome:

To determine the turbidity of the given sample of water.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of turbidity of water for domestic and industrial water supply is important to decide quality of water. High turbidity indicates presence of mud particles and bacterial contamination in water which decides further purification processes of water treatment.**

a. Determination of turbidity of given sample of water
b. Comparing two water sources based on their turbidity.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

Turbidity is the cloudiness or haziness of a fluid caused due to large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. Some examples of the problems caused by high turbidity include. When there are more particles in the water, temperature increases. Warmer water holds less dissolved oxygen. If water has high turbidity, it shows its less transparency on turbidity meter in respective unit. Turbidity is usually measured in *Nephelometric* Turbidity Units (NTU) or Jackson Turbidity Units (JTU), depending on the method used for measurement.

VIII. Experimental Set-up

Figure1: Digital Turbidity Meter.

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Digital Turbidity Meter	Range 0 to 200NTU, Resolution 1NTU, Accuracy: ± 3% FS, ± 1Digit, Display3½ Digit 7-Segment LED Light Source6V, 0.3Amp Tungsten Lamp, Detector: Photodiode, Sample System:30 mm Clear Glass Test Tubes, Power230 V ± 10% AC, 50 Hz, Accessories Test tube Set of 5, Operation Manual, Dust Cover	1 No.	Per batch
2.	Beaker	Standard glassware beaker of 500 ml. capacity	3 Nos.	Per batch

X. Procedure

1. Calibration and Standardization

Turbidity Meter calibration: The manufacturer's operating instructions should be followed. Measure standards on the turbidity meter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales. At least one standard should run in each instrument range to be used. Some instruments permit adjustments of sensitivity so that scale values will correspond to turbidities. Solid standards, such as those made of Lucite blocks, should never be used due to potential calibration changes caused by surface scratches. If a pre-calibrated scale is not supplied, calibration curves should be prepared for each range of the instrument.

2. Measurement

a. Turbidities less than 40 units: If possible, allow samples to come to room temperature before analysis. Mix the sample to thoroughly disperse the solids present in it. Wait until air bubbles disappear and then pour the sample into the turbid meter tube. Read the turbidity directly from the instrument scale or from the appropriate calibration curve.

b. Turbidities exceeding 40 units: Dilute the sample with one or more volumes of turbidity-free water until the turbidity falls below 40 units. The turbidity of the original sample is then computed from the turbidity of the diluted sample and the dilution factor. For example, if 5 volumes of turbidity-free water were added to 1 volume of sample, and the diluted sample showed a turbidity of 30 units, then the turbidity of the original sample was 180 units.

c. Some Turbidity Meters are equipped with several separate scales. The higher scales are to be used only as indicators of required dilution volumes to reduce readings to less than 40 NTU.

XI. Precautions to be followed

1. Use clean and dry beakers.
2. The Standardization of Turbidity meter is essential before use.
3. Clean and wipe out an outer surface of glass tube.
4. Record reading in steady condition.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

Sr. No.	Particulars	Sample No.		Average Turbidity value (NTU/JTU)
	Type of Sample	1	2	
1	Standard water (Distilled water)			
2	Bore well water			
3	Surface Water			
4	Tap Water			

Sample Calculation

For Observation No.…….

Average Turbidity = Reading (1) + Reading (2) /2 = ……..

Average Turbidity of water sample 1 =……NTU

XVI. Results

The turbidity of given water sample is observed as ……..NTU

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the location of bore and surface water sample.
2. Give the reason of variation in turbidity of water sample.
3. State the importance of calibration of equipment before measurement of turbidity.
4. State the acceptable limit of turbidity value for drinking water.
5. Suggest the treatment to reduce turbidity and to obtain it in acceptable limit.
6. State how high turbidity will affect on the other treatment processes of purification.
7. State the reason of high turbidity during rainy season.
8. Give the significance of high turbid water.
9. State the standard permissible values of Turbidity for potable water.

Space to Write Answers

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XX. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Calibration of the instrument	30 %
2	Recording of observations	30 %
Product related:10 Marks		**40%**
3	Interpretation and Conclusion	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 3: Residual Chlorine in Water

I. Practical Significance

Chlorine and chlorine-based disinfectants are used worldwide to destroy germs in drinking water and swimming pools. One of the reasons for the widespread use of chlorine disinfectants is that they provide a "residual" level of protection against waterborne pathogens. Chlorine residual is a low level of chlorine remaining in water after its initial application. It constitutes an important safeguard against the risk of subsequent microbial contamination after treatment—a unique and significant benefit for public health.

The presence of free residual chlorine in drinking water is correlated with the absence of disease-causing organisms, and thus is a measure of the potability of water.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and wastewater.

IV. Practical Outcome:

To determine residual chlorine in a given sample of water.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"The presence of chlorine residual in drinking water indicates that: 1) a sufficient amount of chlorine was added initially to the water to inactivate the bacteria and some viruses that cause waterborne disease; and, 2) the water is protected from recontamination during distribution"**

a. Determination of presence of residual chlorine in sample of water
b. Comparing two water samples based on presence of residual chlorine.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

Chlorination is the process of adding chlorine to drinking water to disinfect it and kill germs. Different processes can be used to achieve safe levels of chlorine in drinking water.

When chlorine is added to water, it forms hypochlorous acid and hypochloric acids within few seconds at temperature between 49^0F and 212^0F.

$$Cl_2 + H_2O \xrightarrow{pH > 5} HOCl + HCl$$

(Hypochlorous acid)

The hypochlorous acid is unstable and may break into hydrogen ion and hypochlorite ions.

$$HOCl \underset{pH < 7}{\overset{pH > 8}{\rightleftharpoons}} H^+ + OCl^-$$

(Hydrogen ions) (Hypochlorite ions) pH

The above reaction is reversible and depends upon the pH value of water, which controls the amount of dissociation at pH > 5; Chlorine exists as elemental or molecular chlorine and does not react with water at pH < 5. At pH value between 5 to 7, HOCl will generally exist without dissociating into OCl^- ions and at pH greater than 10 only OCl^- ions are found. As the hypochlorous acid is destructive hence pH value of water during chlorination is generally maintained slightly less than 7, so as to keep the dissociation of HOCl to minimum. The chlorine will immediately react with ammonia present in water to form various chloramines.

$$NH_3 + HOCl \longrightarrow NH_2Cl + H_2O$$

Mono-chloramines

$$NH_2Cl + HOCl \longrightarrow NHCl_2 + H_2O$$

Di-chloramines

$$NHCl_2 + HOCl \longrightarrow NCl_3 + H_2O$$

Nitrogen- Trichloramine

VIII. Experimental Set-up

Figure 1: Chloroscope

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Chloroscope	Orthotolodine test kit (free and total **chlorine testing** for EPA reporting over the range of 0-4 mg/L.)	1 No.	Per batch
2.	Beaker	Standard glassware beaker of 500 ml. capacity	3 Nos.	Per batch

X. Procedure

1. Fill the three test tubes in the front row of the comparator box with the given water sample up to the given marking.
2. Add 6 drops or 5ml of standard orthotolidine solution in middle test tube and mix with stirrer.
3. A yellow color will be developed in first 5 seconds indicating the presence of free chlorine.
4. Fill distilled water in central tube of the back row.
5. Take two standard color samples in side tubes of back row.
6. Observe from front side against sufficient white or natural light.

7. Compare the color developed in the water sample with standard color, after 5 minutes of addition of orthotolidine solution.
8. The standard colors in two sides of back row may be replaced to obtain a good matching.
9. The known value of chlorine in mg/lit contained in standard colour, which matches with colour developed in water sample, will indicate the contained residual chlorine in given water sample.

XI. Precautions to be followed

1. Use clean and dry Test tubes.
2. After adding orthotolidine solution mix it thoroughly.
3. Place distilled water in central tube of back row.
4. Observation should be done against sufficient white or natural light.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

Sr. No	Sample Details	Residual Chlorine (mg/L)
1		
2		
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4		

XVI. Results

The residual chlorine for given water sample is observed as …….. .

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the different methods of disinfection.
2. State the importance of residual chlorine in water.
3. State the minimum concentration of residual chlorine in water at the consumer end.
4. State the various methods to determine the residual chlorine in water.
5. Write effects of excessive residual chlorine in water.
6. Give essential qualities of disinfectant.
7. Write various forms of chlorination.
8. Define break point chlorination.
9. How the colour changes after addition of orthotolidine solution in water sample?
10. Suggest suitable method of disinfection in swimming pool water.

Space to Write Answers

XX. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Adding and mixing solution	30 %
2	Comparing solution and recording of observations	30 %
Product related:10 Marks		**40%**
3	Interpretation and Conclusion	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 4: Suspended Solids, Dissolved Solids and Total Solids

I. Practical Significance

Estimation of total dissolved solids is useful to determine whether the water is suitable for drinking purpose, agriculture and industrial purpose. The term "solids" is generally used when referring to any material suspended or dissolved in water that can be physically isolated either through filtration or through evaporation. Total solids are dissolved solids plus suspended and settleable solids in water. Dissolved solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other ions particles. Suspended solids include silt and clay particles, plankton, algae, fine organic debris, and other particulate matter.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and waste water.

IV. Practical Outcome:

To determine suspended solids, dissolved solids and total solids in given sample of water.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of total solids, suspended solids and dissolved solids to check quality of water for domestic and industrial water supply."**

a. Determination of total solids value of given sample of water
b. Deciding further treatment required based on the total solids.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

- **Total Solids (TS):** This is the matter that remains as residue upon evaporation and drying of water sample at 103^0 C - 105^0 C in an oven. This is called Total solids.
- **Suspended Solids (SS):** These are the solids in raw water/wastewater that remain present on filter paper after filtering the sample through a fine filter.(Whatman's Filter paper No.42).The suspended solids contain much of the organic matter.
- **Dissolved Solids (DS):** The filtrate remaining in beaker after filtering the sample through filter contains dissolved solids. It includes mainly inorganic salts, small amount of organic matter and dissolved gases.
- **Fixed Solids:** The residue remain after the ignition of the sample in muffle furnace at 550^0C represents the fixed solids. These represent the organic matter in water.
- **Volatile Solids:** The difference between the suspended solids and fixed solids represent the amount of organic matter present in water.

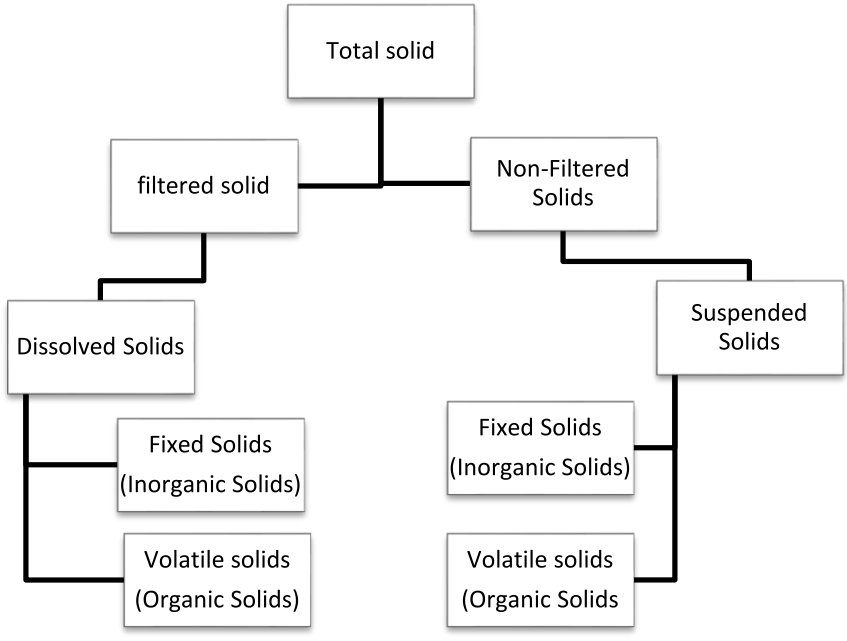

Figure 1 : Classification of Total solids

VIII. Experimental Set-up

Whatman's filter paper

Evaporating Dish

Hot Air Oven

Figure 2: Total Solids Set up

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Hot Air Oven	Electric Oven with digital control(Tempertature:300^0 C. 25 kg capacity)	1 No.	Per batch
2.	Evaporating Dish	Standard glassware or Porcelain dish of 90 mm diameter and 100 ml capacity.	3 Nos.	Per batch
3.	Filter Papers	Whatman's filter paper No.42	1 No.	Per batch
4.	Weighing Balance	Electronic weighing balance of accuracy 0.01 g	1 No.	Per batch

X. Procedure

- **For Total Solids:**
  1. Weigh the given porcelain dish (clean & dry) and record its weight (W_1) gm.
  2. Take 100 ml of sample in porcelain dish.
  3. Place the dish in an oven.
  4. Evaporate to dryness in an oven at 103^{0}C to 105^{0}C for about 24 hrs.
  5. Cool the dish and weight it (W_4).
- **For suspended solids.**
  1. Take a whatman's filter paper no. 42 and record its weight (W_3) gm.
  2. Filter 100 ml sample of water by using above filter paper.

3. Place the filter paper with residue in an oven and evaporate it to dryness.
4. Read the weight of the filter paper and residue (W_4).

XI. Precautions to be followed

1. Use clean and dry evaporating dish.
2. Take weight and record carefully.
3. Maintain temperature of oven as per requirement.
4. Record the temperature of room.
5. Record weight in steady condition.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

- **For Total Solids (TS)**

Sr. No	Name of Water/Type of Sample	Volume of Sample(mL)	Weight of dish (gm)		
			Initial (W_1)	Final (W_2)	Difference (W_2-W_1)

- **For Suspended Solids (SS)**

Sr. No	Name of Water/Type of Sample	Volume of Sample(mL)	Weight of filter paper (gm)		
			Initial (W_3)	Final (W_4)	Difference (W_4-W_3)

Sample Calculation:

1. **Concentration of Total Solids**,(mg/L) = $\frac{(W_2-W_1) \times 1000 \times 1000}{\text{Volume of Sample in mL}}$

   = ----------

   = ----------mg/L

2. **Concentration of Total Suspended Solids**,(mg/L) = $\frac{(W_4-W_3) \times 1000 \times 1000}{\text{Volume of Sample in mL}}$

   = ----------

   = ----------mg/L

3. **Concentration of Total Dissolved Solids**,(mg/L) = (Conc. of TS) – (Conc. of SS)

= ----------

= ----------mg/L

XVI. Results

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XVII. Interpretation of results*(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations*(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the permissible limit of total solids in drinking water.
2. State the terms “fixed” and “volatile” solids in water.
3. State the effects of high concentration of dissolved solids in water for domestic use.
4. State the effects of high concentration of dissolved solids in water for industrial use.
5. Explain the effects of solids in water treatment.
6. Suggest the treatment for bringing total solids in acceptable limit.
7. State the reason of high concentration of total solid in water.
8. Comment on seasonal variation in TS value of drinking water.
9. Suggest physical and chemical treatment for reducing TS, SS and TDS of water.

Space to Write Answers

XX. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	Dhanpat Rai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Recording of weight	20 %
2	Process with filtration and oven	20 %
3	Calculations from recorded weights	20 %
Product related:10 Marks		**40%**
3	Interpretation and Conclusion	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 5: Dissolved Oxygen in Water

I. Practical Significance

Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water and is particularly important in aquatic ecology. Dissolved oxygen (DO) is one of the most important indicators of water quality. It is essential for the survival of fish and other aquatic organisms. Oxygen dissolves in surface water from atmosphere. Dissolved oxygen concentrations are constantly affected by diffusion and aeration, photosynthesis, respiration and decomposition. While water equilibrates toward 100% air saturation, dissolved oxygen levels will also fluctuate with temperature, salinity and pressure changes

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and wastewater.

IV. Practical Outcome:

To determine dissolved oxygen in a sample of water.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of dissolved oxygen decides suitability of water for aquatic life also for Domestic drinking water supply. Low dissolved oxygen levels indicate an excessive demand of the oxygen in the system. A high DO level in a source water supply is good for community because it makes drinking water taste better. However, high DO levels speed up corrosion in water pipes."**

a. Determination of dissolved oxygen in given sample of water
b. Comparing two water sources based on their DO content.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

Dissolved oxygen is used as an indicator of water quality and eutrophication status of surface water. The term Dissolved Oxygen (DO) refers to the amount of free oxygen dissolved in water which is readily available to respiring aquatic organisms. As dissolved oxygen levels in drinking water should be 5.0 mg/l. Aquatic life is put under stress if the lower the concentration. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills. For the conclusion, Dissolved oxygen content is direct measure of freshness of water and hence determination of its presence is important.

VIII. Experimental Set-up

Figure 1: Digital DO meter.

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Digital DO meter	Range: 0 to 20 ppm, Resolution: 0.1 ppm, Temperature Compensation: 0 to 50 ^{0}C.	1 No.	Per batch
2.	Beaker	Standard glassware beaker of 500 ml. capacity	3 Nos.	Per batch

X. Procedure

1. Calibration Before measurement

- Disconnect the " OXYGEN PROBE plug " from the main instrument " Input socket “
- Power on the instrument by selects the “On/Off Switch “to the “On " position. Slide the “DO / CAL Switch “to the “CAL" position. Adjust the “ZERO Adj. VR “until the display shows zero value.
- Power off, connect the “OXYGEN PROBE plug “to the main instrument “Input Socket “then power on. Wait 5 minutes at least until the display reading values become stable & no fluctuation. Adjust the “CAL Adj. VR” until the display reading shows the values exact same as 20.9 (As the oxygen in air is 20.9 % typically) (Calibration consideration: Please make calibration procedures under wide and ventilating environment for best effect.)

2. Dissolved Oxygen (DO) measurement

- After the meter be calibrated, don't adjust the " CAL Adj. VR " & " ZERO Adj. VR " again until next calibration procedures be done
- Slide the “DO / CAL Switch “to the “DO " position.
- Immersed the probe to a depth at least 10 cm of the measured liquid in order for the probe to be influenced by the temp. & automatic temperature compensation to take place. As for the thermal equilibrium to occur between the probe & the measurement sample must be allowed to pass, which usually amounts to a few minutes if the temp. Difference between the two is only several C degrees.
- In order to measure the dissolved oxygen content in any given liquid, it is sufficient to immerse the tip of the probe in the solution, making sure that velocity of the liquid coming into contact with the probe is at least 0.2 - 0.3 m/s or shake the probe. During laboratory measurements, the use of a magnetic agitator to ensure a certain velocity in the fluid is recommended. In this way, errors due to the diffusion of the oxygen present in the air in the solution are reducing to a minimum.
- Rinsed the probe accurately with normal tap water after each series of measurement.

XI. Precautions to be followed

1. Use clean and dry beakers.
2. The Standardization of DO meter is essential before use.
3. Clean and wipe out probe/electrode every time of immersion.
4. Record the temperature of room.
5. Record reading in steady condition.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

Sr. No.	Particulars	Sample No.		Average DO
	Type of Sample	1 (mg/l)	2(mg/l)	(mg/l)
1	Tap water (Treated water)			
2	Bore well water			
3	Surface water (Lake, River)			

Sample Calculation

For Observation No.…….

Average DO = DO (1) + DO (2) /2 = ……..

Average DO of Tap water. =……

Average DO of Bore water. =……

Average DO of surface water. =……

XVI. Results

The dissolved oxygen in untreated or raw water is observed as ……..mg / l.

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the location of bore and surface water sample.
2. Give the reason of variation in DO due to temperature.
3. Justify the difference in DO values for above samples.
4. Give the acceptable limit of DO value for drinking water.
5. Suggest the treatment for DO to obtain it in acceptable limit.
6. State how DO value will affect on the other treatment processes of purification.
7. State the effects on aquatic life if water is having DO less than 2 mg/l.
8. Suggest treatment for increasing dissolved oxygen in water.
9. Comment on variation in DO due to its location.

Space to Write Answers

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XX. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Calibration of the instrument	30 %
2	Recording of observations	30 %
Product related:10 Marks		**40%**
3	Interpretation and Conclusion	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 6: Water Treatment Plant

I. Practical Significance

The treatment given to water before supplying to the public for domestic use is called water treatment i.e. complete process of removing impurities / objectionable matter in order to make the water acceptable for drinking purpose.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Draw the flow diagram for process of treatment of water and wastewater.

IV. Practical Outcome:

To undertake field visit to water treatment plant.

V. Competency and Practical Skills

This practical is expected to understand operation and maintenance of water treatment plant. **"Study of different units and process of water purification executed at water treatment plant."**

a. Collection of information for technical report on W.T.P.
b. Preparing a report using different process diagrams and collected information.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

Water treatment plant has different units through which raw water get clarified in the successive order. Process of treatment of raw water is

1. Screening 2. Aeration 3.Sedimentation 4. Filtration 5. Disinfection

VIII. Concept Structure

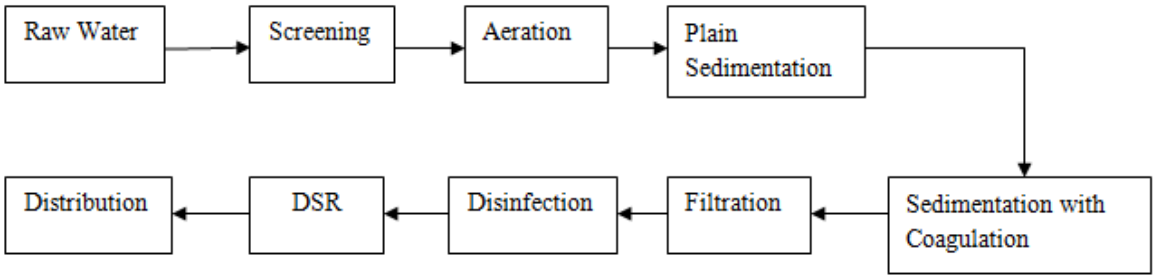

Figure 1: Flow diagram of water treatment plant.

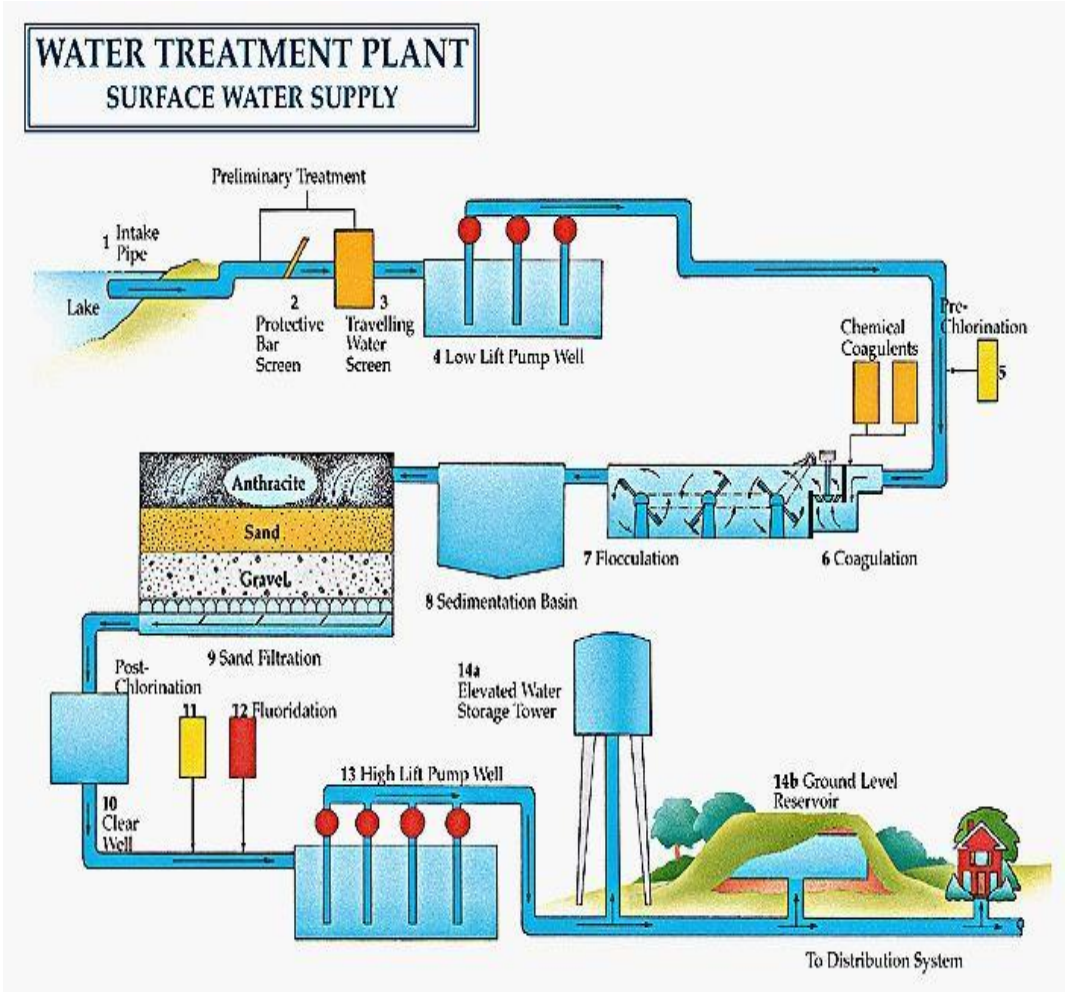

Figure 2: Layout of water treatment plant.

IX. Format of Visit Report

A. Date of Visit:----------

Place of Visit:----------

Address of Visit place:----------

B. Information of W.T.P

1. Governing body of W.T.P……..

2. Daily raw water intake (m^3/day or MLD) …….

3. Source of water…….

4. Out flow of plant……

5. Intake water characteristics……..

6. Daily out flow……

7. List of various parts and their function……

8. Frequency of suspended particles removed per day……

9. Type and dosage of coagulant…….

10. Type and dosage of disinfectant……

11. Any other additional information……...

12. Draw labeled sketch of filtration unit……..

13. Draw flow diagram of W.T.P……

X. Precautions to be followed

1. Take prior permission from concern department(MJP/Nagarpalika/Municipal corporation) well in advance
2. Maintain discipline during journey and at WTP.
3. Record all necessary information in note book.
4. Wear college uniform, shoes, cap, dupatta, sun- glass during visit.
5. Keep safe distance from moving parts/ machines at site.

XI. Actual Visit Report followed *(Use blank sheet if provided space is not sufficient)*

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XII. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Define aeration of water.
2. State different types of aerators.
3. Define plain sedimentation and sedimentation with coagulation.
4. Explain process of filtration
5. State function of clariflocculator.
6. State difference between rapid sand filter and slow sand filter.
7. Write drawbacks of slow sand filter.
8. State importance of chlorination.
9. Define residual chlorine.
10. Explain different types of distribution systems.

Space to Write Answers

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XIII. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XIV. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Punctuality for visit timings	30 %
2	Behavior at visit location	30 %
Product related:10 Marks		**40%**
3	Interpretation and report writing	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 7: Optimum Dose of Coagulant by Jar Test.

I. Practical Significance

Jar testing is a method of simulating a full scale water treatment process and system operators can use jar testing to determine, which chemical treatment with optimum dose will work best in their treatment of raw water. The amount or dosage of a coagulant and/or flocculent required to precipitate are decided on the basis of jar test. The **jar test procedure** is intended to simulate the coagulation/flocculation process and determine appropriate dosages.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and wastewater.

IV. Practical Outcome:

To determine the optimum dose of coagulant in the given raw water sample by jar test.

V. Competency and Practical Skills

Jar testing is a method of simulating a full scale water treatment process and system operators can use jar testing to decide optimum dose that will work best in their treatment of raw water. **"Determination of optimum dose of coagulant to remove load of suspended particles from water and deciding dosage for drinking water treatment plant."**

a. Understanding concept of coagulation.
b. Interpretation of results and determination of optimum dose of coagulant.

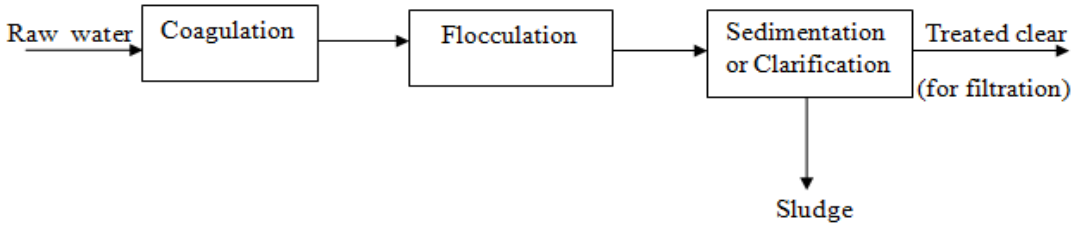
VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

Precipitation is the chemical conversion of soluble substances into insoluble particles. Coagulation and flocculation causes a chemical reaction that promotes the formation, agglomeration or clumping of such particles to facilitate their removal from solution. The lab scale results are used to optimize the performance of systems such as water treatment plants by determining the concentration of coagulant to be added in the treatment of water.

In this process first coagulants are added and mixed in water to produce required precipitate, then water is sent to sedimentation tank where sedimentation of fine and colloidal particles takes place through the precipitate.



VIII. Experimental Set-up

Figure 1: Jar Test Apparatus.

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Jar Test Apparatus	Jar Test Apparatus (Digital timer: 1 to 99 minutes, material: Stainless steel, Power: Electric supply, Range: 25 to 250 rpm,	1 No.	Per batch
2.	Beaker	6 glass jars (of 1000 mL) of Standard glassware	6 Nos.	Per batch
3.	Reagents	Alum($Al_2(SO_4)_3.18H_2O$) Solution (Made by dissolving 14.28 gm of alum in one liter distilled water.)	10 ml (Apprx.)	Per batch

X. Procedure

1. Fill 1 liter water sample in each of the six jar.
2. Find the pH of the samples and adjust it to 6 to 8.5.
3. Attach the sample jars to stirring device by lifting the paddles in the right upward direction.
4. Add coagulant solution in progressive volumes of 0.25ml, 0.5ml, 0.75ml, 1.0ml and 1.5ml into the series of the six sample jars.
5. Flocculate the sample rapidly for about one minute with mechanically operated paddles @ 60- 80 rpm, followed by gentle stirring @ 30rpm for 15 minutes.
6. Stop the machine, lift out paddles and let the sample stand for 30 minutes for settling of floc.
7. Select the minimum dosage giving the best floc formation and clear water.

XI. Precautions to be followed

1. Use clean and dry beakers.
2. Recording of pH value is essential before adding coagulant.
3. Take dose of coagulant precisely.
4. Record the temperature of room.
5. Observe floc after complete settlement in steady condition.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications Details	Quantity	Remark
1				
2				
3				
4				

XIV. Precautions followed

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XV. Observations

Jar No	Sample of raw water (L)	Amount of coagulant added in mL	Observation in regard of quality of floc formed
1			
2			
3			
4			
5			
6			
Selected optimum dosage (y) = ……. mL/L			

Sample Calculation

- Selected optimum dosage (y) = ……..mL/L
- Strength of alum prepared = …….. gm/L

  =…….. mg/ml

- Optimum dosage in mg/L = ……..mg/ml X……..mL/L

  =…….. mg/ml

XVI. Results

The optimum dose of alum for a given sample of raw water is found to be ……mg/L..

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Define plain sedimentation.
2. Explain sedimentation with coagulation.
3. State reason for sedimentation with coagulation is required in treatment of water.
4. List common coagulants used in water treatment.
5. State the factors affecting the process of coagulation.
6. State advantages of alum as commonly used coagulant.
7. State the term Floc.
8. State the term “flocculation”.
9. State the factors which affect the rate of flocculation.
10. Explain the mechanism of floc formation.
11. Explain the working of clariflocculator unit in water treatment plant.

Space to Write Answers

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XX. References / Suggestions for further Reading

Sr.No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Recording as per dosage of alum	30 %
2	Process of clariflocculation	30 %
Product related:10 Marks		**40%**
3	Interpretation and Conclusion	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 8: Valves in Water Supply Pipe

I. Practical Significance

In the distribution system of water different parts are connected according to their function such as pipes, pumps, valves and other fixtures. To maintain smooth and efficient working of water distribution system valves are necessary. Study of each valve with its function is equally important in subjects of public health and town planning.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify various accessories for efficient conveyance and distribution of water.

IV. Practical Outcome

To draw sketches of various valves used in water supply pipe line.

V. Competency and Practical Skills

Different types of valves are used in water supply system. This practical is expected to study various valves with their function and location. **"Study of various valves based on their function and location provided for smooth working of water supply system"**

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

Valves play an important role in a water distribution system for subsystem connection or disconnection. They play vital role in pressure or flow control, flow diversion and in stoppage of flow. Valves are provided for the following purposes

a) To control the rate of flow of water.
b) To release or admit air into the pipeline.
c) To prevent or detect leakage.
d) To meet the demand during emergencies
e) To enable repairs and maintenance of pipe network.
f) To make the distribution system more efficient.

VIII. Different types of Valves

Sr.No.	Name of valve	Diagram
1.	**Sluice Valve** It is also known as gate or stop valves. These valves are provided in pipeline to control the flow of water.	
2.	**Air relief valve** It is used for automatic allowance of air to escape through pipeline. They are provided at summit points in the alignment of pipe.	
3.	**Pressure relief valve** It is also known as safety valve. They are provided to relieve pressure automatically, when it exceeds a fixed limit.	
4.	**Scour valve** It is also known as the blow-off valves or drain valves or washout valves. These are used to remove sand or silt deposited in pipeline.	

5.	**Reflux valve** It is also known as non-return valves or check valves. These are used in a pipeline when it is required to pass the discharge only in one direction.	

IX. Students Activity

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X. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaia h	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XI. Suggested Assessment Scheme

Performance Indicators			Weightage (%)
Sr.No	**Tasks**	**Marks**	**100%**
1	Writing short notes	10	30%
2	Sketches/ Drawings	10	30%
3	Submission of report in time.	5	40%
Total: 25 Marks			**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 09: One Pipe & Two Pipe Plumbing System

I. Practical Significance

Whenever any kind of liquid waste is generated from any part of the building or structure, it should be drained out as quickly as possible. The quick removal of waste water is governed by the fall of the pipes. The drains should be laid at such a slope that self-cleaning velocity is developed in them. All the drainage system should be properly ventilated on the house side. The ventilation pipes should be carried sufficiently high above the building. There should be the provision of fresh air inlets.

The plumbing arrangement should be such that in future extension can be done easily if desired. Automatic flushing arrangement should be provided in case of less quantity of sewage. All the rain water pipe, sweeping from house and bath water should discharge over gully traps and should be disconnected from the drain. As well as all soil pipes should be carried direct to the manholes without gully traps.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10.Life long learning: *Engage in independent and lifelong learning activities in the context of technological changes also in the Civil engineering and allied industry..*

III. Relevant Course Outcomes

Draw labeled systems of plumbing for building sanitation.

IV. Practical Outcome:

To draw a sketch of one pipe and two pipe system of plumbing

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Understand the types of plumbing arrangement for the effective sanitation and drainage arrangement for wastewater generated from domestic and industrial buildings"**

To draw a sketch of one pipe and two pipe system of plumbing

a. Drawing the sketch of one pipe plumbing system
b. Drawing the sketch of two pipe plumbing system

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

There are different types of plumbing systems adopted according to the need and situation, they are a) Two – pipe system

b) One – pipe system

c) Single stack system

d) Single stack partially ventilated system

Two-pipe system: This is the most common system used in India. This method provides an ideal solution, where it is not possible to fix the fixtures closely. In this system two pipes are provided. One pipe collects the foul soil and lavatory wastes, whereas the second pipe collects the unfoul water from kitchen, bathrooms, house washings, rain water etc. The soil pipes (pipes carrying the soil waste) are directly connected to the drain, whereas the waste pipes (pipes carrying unfoul waste water) are connected through the trapped gully. All the traps used in this system are fully ventilated.

One-pipe system: In this system only one main pipe is provided which collects both the foul soil waste as well as unfoul waste from the buildings. The main pipe is directly connected to the drainage system. If this system is provided in multi-storeyed buildings the lavatory blocks of various floors are so placed one over the other, so that the waste water discharged from the different units can be carried through common vertical stocks connected through short branch drains. All the traps of the W.C., basins, sinks, etc. are fully ventilated and connected to the ventilation pipe. But all the gully traps and waste pipes are completely dispensed with.

Single-stack system: This is similar to single pipe system, the only difference being that no ventilation is provided even in the traps too.

Single-stack partially ventilated system: This system is in between the one and single-stack system. In this system only one pipe is provided to collect all types of waste water foul as well as unfoul. A relief vent pipe is provided for ventilating only the water closet-traps.

VIII. Experimental Set-up

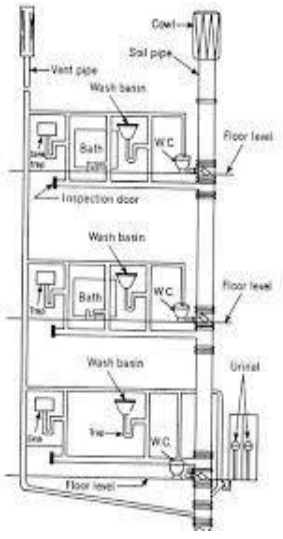

Figure 1 : One pipe Plumbing System

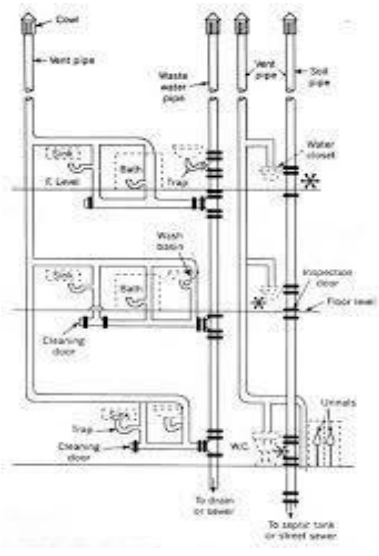

Figure 2: Two pipe Plumbing System

Drawing Board: 60 x 40 cm size

Drawing Instruments/ Accessories: Standard Mini Drafter, Scale, Roller, Pencil, Eraser, Set Square, Drawing Clips, French Curve (if required)

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Drawing Sheet (Drawing Plate)	A4 size	02 Nos.	Individually
2	Drawing accessories Mini Drafter, Scale, Roller, Pencil, Eraser, Set Square, Drawing Clips, French Curve (if required)	--		According to individual requirement
3	Typical drawings of one pipe and two pipe plumbing system.	--		

X. Procedure

1. Select the typical sketch of One pipe plumbing system or Two pipe plumbing system
2. Select the time slot for drawing purpose.
3. Get the proper instructions from the teacher.
4. Observe the sketch obtained scrupulously
5. Analyze the accessories and arrangement provided in that specific sketch related to one pipe or two pipe plumbing system.
6. Draw the proper / neat / labeled sketch (may not be to the scale)
7. Prepare the table of accessories provided for the plumbing arrangement with its specification , quantity , remarks if any (table is optional)

Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XI. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XII. Precautions to be followed

1) Sketch of one pipe system and two pipe plumbing system may not be to the scale, but it should represent with appropriate legends.
2) Observe the standard books, handbooks or concerned literature while drawing.
3) There should be uniformity in the drawing.

XIII. Observations

Sr. No.	Particulars			Remark
	Types of Plumbing system	1	2	
1				
2				
3				

XIV. Results

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XV. Interpretation of results *(Give meaning of the above obtained results)*

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XVI. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XVII. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the types of plumbing system proposed for the buildings.
2. List the various types of pipes provided in the plumbing arrangement.
3. State the purpose of gully trap.
4. State the purpose of Nahani trap. Where it is provided in the plumbing system.
5. State the purpose of antisiphonage pipe.
6. State the materials used for manufacturing of soil pipe.
7. State the advantages of stoneware pipe.
8. State importance of gradient of drain pipe provided in the plumbing arrangement.
9. What are the specific precautions to be taken during the plumbing arrangement in multistoried buildings?
10. How the following possibilities can be avoided in the plumbing arrangement
    - i) Formation of air locks
    - ii) Siphonage
    - iii) Undue deposition of waste impurities
    - iv) Obstructions to the flow

Space to Write Answers

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XVIII. References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XIX. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Punctuality for Drawing	30 %
2	Behavior at the time of drawing	30 %
Product related:10 Marks		**40%**
3	Interpretation and report writing	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Name / Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 10: Biochemical Oxygen Demand in Wastewater

I. Practical Significance

Biochemical Oxygen Demand (BOD) is defined as the amount of Oxygen required by heterotrophic aerobic microorganisms, in stabilizing the biologically degradable organic matter under aerobic condition. BOD value indicates the pollution strength of organic matter in domestic or industrial wastewaters. It can be useful for designing suitable treatment methods, organic loadings of treatment plant and also for evaluating efficiencies of unit operations and treatment systems. This test is useful for determining the suitability of treated effluents for disposal with reference to recommended standards as well as for carrying out stream sanitation studies and for enforcing water pollution control measures.

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II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and lifelong learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Explain the sources and characteristics of water and wastewater.

IV. Practical Outcome:

To determine the Biochemical Oxygen Demand of wastewater.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of Biochemical Oxygen Demand decides suitability of waste water for discharging in water body after proper treatment. A low value of B.O.D. indicates less amount of organic matter in the wastewater. A high B.O.D. indicates more amounts of organic pollutants in the waste water.**

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

The organic matter which is biologically oxidized or reduced is called biologically active material. The organic matter which cannot be biologically oxidized is called biologically in- active or biologically non-degradable.

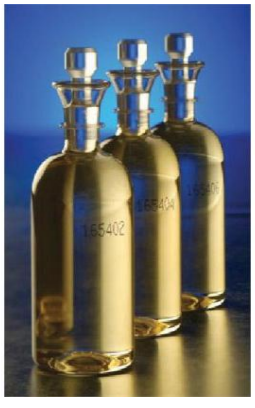
Biochemical Oxygen Demand is the amount of oxygen required by microorganisms (aerobic bacteria) in stabilizing the biologically degradable organic matter under aerobic conditions. After stabilization the end product of aerobic reactions are CO_2 and H_2O.

$$\text{Wastewater} \xrightarrow[\text{Reaction}]{\text{Aerobic}} CO_2 + H_2O$$

Polluted water will continue to absorb oxygen for many months to decompose the organic matter present in it. It is not practically feasible to determine the ultimate oxygen demand. Hence the B.O.D. of water during 5 days at 20 °C is generally taken as the standard demand which is known as BOD_5 and is about 68 to 80% of the total demand. A 10 day BOD is about 90% of the total oxygen demand.

VIII. Experimental Set-up

Digitally controlled BOD Incubator



BOD Bottles

Figure 1: BOD Incubator with BOD Bottles (Refer the manual)

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Aerator	--	1 No.	Per batch
2.	BOD Incubator	Inner working chamber size- 3 Cu.ft Temperature Rang- 5°C TO 60°C Accuracy - +/- 0.5°C Power Supply- 230 Volts , 50 H_2 PID Digital Temp Controller Cum Indicator	1 No.	Per batch
3	Set of BOD Bottles	Standard capacity 300 ml. capacity	5 Nos.	Per batch

X. Procedure

Reagents:

1) Dilution water saturated with air- sufficient quantity of distilled water is aerated with aerator air compressor for more than 8-10 hours, and the aerated water is kept at low temperature till use. At the time experiment this water is used for preparation of different dilution of the sample.
2) Seed: Sewage (fresh) is settled for 20 hrs. and the supernatant is used as seed. Quantity of seed should be chosen such that it won't exert more than 20% depletion of DO.
3) Buffers and Nutrients-
   - Phosphate buffer:
     Dissolve 8.5 gm. KH_2PO_4, 21.75 gm. K_2HPO_4, 33.4 gm. $Na_2HPO_47H_2O$ and 1.7gm NH_4Cl in 500 ml distilled water. Dilute to 1 liter. pH of the solution is 7.5
   - Magnesium sulphate ($MgSO_4$)
   - Calcium chloride solution ($CaCl_2$).
     Dissolve 27.5 gm. Anhydrous $CaCl_2$ in distilled water and make the volume to 1 liter.
   - Ferric chloride solutions ($FeCl_3.8H_2O$)
     Dissolve 0.25 gm. of $FeCl_3.H_2O$ in distilled water and make the volume to 1 liter.
4) Alkali Iodide solution
5) Concentrated H_2SO_4
6) Sodium thiosulphate 0.025 N
7) Starch Indicator.

Stepwise procedure:

A. Preparation of dilution water.

1. Prepare dilution water saturated with air as discussed earlier.
2. Add 1 ml. each of phosphate buffer, magnesium sulphate and calcium chloride and ferric chloride solution for each liter of dilution water and mix it well.
3. In case of the waste which is not expected to have sufficient bacterial population add seed.

B. Dilution of sample.

1. Neutralize the sample to pH around 7.0, if it is highly alkaline or acidic. For acidifying do not use organic acid, use only mineral acid.
2. Sample having high DO content i.e. DO 9 mg/l due to either algal growth or some other reason, reduce the DO content by aerating and agitating samples.
3. Make the several dilution of sample to obtain required depletion. Following dilutions and suggested.
   - 0.1 to 1% for strong treated waste
   - 1.0 to 5.0% for raw settled waste
   - 5 to 25.0% for oxidized effluent and
   - 25.0 to 100% for polluted river waters
4. Prepare the desired mixture by adding sample in dilution water.
5. Fill up one 300 ml bottle with the mixture and other one with dilution water (blank) in two sets.
6. Keep one set in BOD incubator for 5 days for incubation at 20°C
7. Determine the DO of blank and sample immediately before incubation (i.e. first day)
8. Determine the DO of blank and sample after incubation for 5 days (i.e. fifth day)

C. Determination of DO for blank and sample on first day

1. Take BOD bottle containing blank.
2. Add 2 ml of manganese sulphate solution by means of pipette, dipping the end of the pipette just below the surface of water in BOD bottle containing blank.
3. Add 2 ml Azide alkali potassium iodide in a similar manner.
4. Inset the stopper with care to extrude bubble and mix by repeatedly inverting and shaking the bottle vigorously.
5. Red precipitate will form if DO is present in water. Allow the precipitate to settle half way, and mix again.
6. Again allow the precipitate to settle half way.
7. Add 2ml of concentrated H_2SO_4 in the same manner as done in step 2 and 3 and insert the stopper and mix up thoroughly as before.
8. Allow the solution to stand for at last 5 minutes to ensure formation of I_2, which is to be titrated against sodium thiosulphate.
9. Take 203 ml of solution in the conical flask.

10. Fill the burette with 0.025 N sodium thiosulphate solution and note the initial burette reading.
11. Titrate the sample immediately with 0.025 N sodium thiosulphate solution, until the yellow colour becomes very light.
12. Add 1 ml of starch solution. This will give blue colour. Now continue the titration by adding sodium thiosulphate drop by drop, till the blue colour just disappears. Record the fine burette reading (B1).
13. Take BOD bottle containing sample.
14. Repeat the procedure from step 2 to 12 and note down the initial and final burette reading (D_1).

D. Determination of DO for blank and sample on 5th day after incubation

1. Take BOD bottle containing blank.
2. Repeat the procedure from step 2 to step 12 as done earlier. Note down the initial and final burette reading (B_2)
3. Take BOD bottle containing sample.
4. Repeat the procedure from step 2 to step 12 as done earlier. Note down the initial and final burette reading (D_2).

Note: For 200 ml of sample the difference in initial and final burette reading in ml directly gives the amount of Oxygen (DO)

XI. Precautions to be followed

1. Use clean and dry Beakers, Burette, Pipette, Flask, BOD Bottles.
2. Proper reagents should be used.
3. Preparation of dilution water and Dilution of sample should be done properly.
4. Determination of DO for the blank and sample should be done with due care.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

Observation table for Biochemical Oxygen Demand

For dilution factor (DF = ……..),

Volume of sample = 200 ml (for calculation)

= 203 ml (actual)

Sr. No.	Source of the sample	Bottle No.	Burette reading		DO (mg/l)	BOD5 (mg/l)
			Initial (1) ml	Final (2) ml	(1-2)	
01	Domestic waste water					
02	Industrial waste water from any* specific industry e.g. i)Sugar Industry ii) Food & Beverages iii) Paint Industry etc. iv) Paper & Pulp Mill					
03	Stagnant surface wastewater (i.e. pond)					

* Any specific industry in the area

Sample Calculation:

$$\text{I) DO (mg/l)} = \frac{\text{ml of sodium Thiosulphate x N x 1000 x 8}}{\text{ml of water sample}}$$

Where, N = Normality of Sodium thiosulphate = 0.025 ml

$$= \frac{ml\ of\ sodium\ thiosulphate\ X\ 0.025\ X\ 1000\ X\ 8}{200}$$

$$= \frac{\ldots\ldots\ldots\ldots\ldots\ldots X\ N\ X\ 1000\ X\ 8}{200}$$

= …… mg/l

By using above formula find out DO for blank and sample on first and fifth day (after incubation) so,

B_1 = ……mg/l

D_1 = ……mg/l

B_2 = ……mg/l

D_2 = ……mg/l

II) BOD in mg/l = $[(D_1 – D_2) - (B_1-B_2)]$ X D.F.

Where,

B_1 - DO of blank before incubation (i.e. first day)

B_2 - DO of blank after incubation (i.e. fifth day)

D_1 - DO of the diluted sample before incubation (i.e. first day)

D_2 - DO of the diluted sample after incubation (i.e. fifth day)

D.F. - Dilution factor

XVI. Results

- BOD_5 of the given sample obtained from Domestic waste water is found to be ……
- BOD_5 of the given sample obtained from Industrial waste water from Sugar Industry is found to be …….
- BOD_5 of the given sample obtained from waste water from Food & Beverages Industry is found to be ……..
- BOD_5 of the given sample obtained from waste water sample from paint Industry is found to be …….
- BOD_5 of the given sample obtained from waste water sample from paper and pulp mill industry is found to be …….
- BOD_5 of the given sample obtained from stagnant surface waste water sample is found to be ……

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the exact location of wastewater sample taken for the testing purpose.
2. Explain biologically active and inactive organic matter.
3. State the roll of aerobic bacteria in stabilizing the waste.
4. State aerobic process in biological treatment.
5. State significance of BOD_5 at 20 ^{0}C.
6. State importance of BOD value in wastewater treatment.
7. State the effect of temperature on the rate of oxidation reaction.
8. Practically in how many days the oxidation reactions get completed.
9. State the necessity of dilution of sample.
10. Give the recommended values of BOD_5 for the disposal of wastewater
    a) In surface water body b) On land for irrigation
11. If BOD_5 value of waste water is more, what does it indicate?
12. If BOD_5 value of effluent is less, what does it indicate?
13. Name the nutrient added for determining the BOD of wastewater.

Space to Write Answers

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XX. References / Suggestions for further Reading

S. No.	Title of Book	Author	Publication
1	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	Dhanpat Rai and Sons, 201ISBN: 81874337954,
3	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60 %**
1	Calibration of the instrument	30 %
2	Operation of Instrument	30 %
Product related:10 Marks		**40 %**
4	Interpretation and conclusion related to the test.	10 %
5	Answers to practical related questions.	20 %
6	Submission of report in time.	10 %
Total: 25 Marks		**100 %**

List of Student Team Members (Name / Roll No.)

1. ……
2. ……
3. ……
4. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 11: pH value of Wastewater

I. Practical Significance

Determination of pH is one of the important objectives considered in evaluation of quality of wastewater generated from different sources of the community. The pH value is having large scale importance in water and wastewater treatments as it controls treatment processes. The pH value of wastewater must be taken into account while deciding treatment of wastewater.

- If pH value is low, wastewater is acidic and it may cause tuberculation and corrosion of sewer pipes.
- If pH value is high, it may produce incrustation, sediment deposit.
- In wastewater treatment efficiency of biological treatment unit reduces due to low and high pH.
- pH value decides neutralization treatment.

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II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and lifelong learning activities in the context of technological changes also in the Civil engineering and allied industry..*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and waste water.

IV. Practical Outcome:

To determine pH value of given wastewater.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of quality of wastewater collected from domestic and industrial wastewater sources of generation."**

a. Determination of pH value of given sample of wastewater
b. Comparing two wastewater sources based on their pH value.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

pH value shows the potential of hydrogen ion concentration present in wastewater sample. The term pH refers to the measure of hydrogen ion concentration in a solution and defined as the negative log of H^+ ions concentration in wastewater. It is an indicator of acidity and alkalinity of wastewater sample.

$$\mathbf{pH = - \log (H^+)}$$

Where H^+ is the concentration of hydrogen ions in moles per liter of wastewater.

The value of pH, 0 to little less than 7 are termed as acidic and values of pH little above 7 to 14 are termed as alkaline. When the concentration of H^+ and OH^- are equal then it is termed as neutral (pH =7)

VIII. Experimental Set-up

Figure 1: Digital pH meter.

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Digital pH meter	4 Digit display (LED), 0 to 1000 mV, Resolution: 0.01 pH manual temp., compensation : 0 to 80 °C	1 No.	Per batch
2.	Beaker	Standard glassware beaker of 500 ml. capacity	3 Nos.	Per batch

X. Procedure

1. Preparation of Buffer solution.

- Take 100 ml of distilled wastewater in a beaker.
- Put the buffer tablet in the distilled water.
- Disperse the buffer tablet in the distilled water by continuously stirring action.
- Prepare the buffer solution of pH value 4.0, 7.0 and 9.2

2. Calibration of the instrument.

The instrument should be calibrated before beginning the measurement

- First rinse the electrode with distilled water and dries its bulb by using tissue paper.
- Dip the electrode in a buffer solution of pH 7.
- Set the temperature (˚C) control to the room temperature.
- Set the function selector to pH position and adjust the CALIBRATE control until the meter displays the precise pH of buffer solution.
- Now the set the function selector switched to STAND BY position.
- Remove the electrode from buffer solution. Wash it with distilled water and wipe out with tissue paper.
- Repeat the above procedure for calibration with buffer solution of 4.0 and 9.2 pH value.

3. Operation of Instrument

- Calibrate the pH meter with two standard buffer solutions as per the above procedure.
- Clean and rinse the electrode thoroughly with distilled water and carefully wipe with tissue paper.
- Dip the electrode into the sample of solution. Stir the solution by keeping on magnetic stirrer or stir it manually.
- Wait up to 1 minute for steady reading +0.1 pH unit.
- Record reading in steady condition after one minute.

XI. Precautions to be followed

1. The standardization of pH meter is essential before use.
2. The reading must be noted when it is stable at least for 30 seconds.
3. The use of electrode should be done very carefully as it is very sensitive and breakable.
4. Record the temperature of room
5. Clean and wipe out electrode every time of immersion.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

Sr. No.	Particulars	Sample No.		Average pH
	Sample No.	1	2	
1	Domestic waste water			
2	Industrial waste water from any specific industry e.g. i)Sugar Industry ii) Food & Beverages iii) Paint Industry etc.			
3	Stagnant surface water (i.e. pond)			

Sample Calculation

For Observation No.…….

- Observed Average value of pH for Domestic waste water sample

pH of sample No. (1) + pH of sample No. (2)/ 2 = …….

- Observed Average value of pH for Industrial wastewater sample

i) pH of sample No. (1) + pH of sample No. (2)/ 2 = …….

ii) pH of sample No. (1) + pH of sample No. (2)/ 2 = …….

iii) pH of sample No. (1) + pH of sample No. (2)/ 2 = …….

- Observed Average value of pH for Stagnant surface water (i.e. pond) water sample pH of sample No. (1) + pH of sample No. (2)/ 2 = …….

XVI. Results

The average value of pH for Domestic waste water sample is found to be ……..

The average value of pH for Industrial waste water sample from Sugar Industries found to be……

The average value of pH for Industrial waste water sample from Food & Beverages Industry is found to be ……

The average value of pH for Industrial waste water sample from paint Industry is found to be ……..

The average value of pH for Stagnant Surface waste water sample is found to be ……..…..

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the location of wastewater sample taken for the testing purpose.
2. Give the reasons for variation in pH value of wastewater samples.
3. State the effect on pH values of wastewater with the passage of time after its generation.
4. State how pH value will affect the treatment process to be adopted for particular wastewater.
5. State the treatments required to bring pH in acceptable limit.
6. State various methods to find pH value of wastewater in a laboratory.

7. Draw a representative pH scale showing values of pH ranging from acidic to alkaline.
8. State the pH range for safe disposal of effluent in surface water.
9. Write specifications of pH meter used for measuring pH in laboratory.
10. Explain calibration process of pH meter used in laboratory.

Space to Write Answers

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3	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Preparation of Buffer solution.	20 %
2	Calibration of the instrument	20 %
3	Operation of Instrument	20 %
Product related:10 Marks		**40%**
4	Interpretation and conclusion related to the test.	10%
5	Answers to practical related questions.	20%
6	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Name / Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 12: Suspended solids, Dissolved solids and Total solids in Wastewater

I. Practical Significance

Solids in wastewater indicate the concentrations of organic and inorganic constituents. The organic fraction defines the pollution load of the wastewater and inorganic component determines its suitability for irrigation or fish culture.

Total solids determination classifies wastewater as weak, moderately strong or strong in nature. Total suspended solids states suitability of wastewater effluents for disposal into inland surface waters. Settleable suspended solids determination indicates the efficiency of primary sedimentation.

Based on this, whether primary sedimentation is required or not and if required, detention time to be adopted for PST design are decided. Volatile solids (settleable) indicate the fraction of organic loading of digesters, contributed by primary sludge from PST. Non settleable suspended solids and non-settleable volatile solids indicate the pollution load to be removed by secondary treatment.

Total dissolved solids (inorganic) indicate the suitability of wastewater for irrigation and fish culture. Total volatile solids determination in sludge is used for designing organic loadings of anaerobic digesters and also their efficiency of volatile solids reduction.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life – long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and waste water.

IV. Practical Outcome:

To determine suspended solids, dissolved solids and total solids in given sample of waste water.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of total solids, suspended solids and dissolved solids to check quality of waste water generated from residential area as well as from industries."**

a. Determination of total solids value of given sample of waste water
b. Deciding further treatment required based on the presence of different forms of solids in the waste water.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

- **Total Solids (TS):** This is the matter that remains as residue upon evaporation and drying of water sample at 103^0 C - 105^0 C in an oven. This is called Total solids.
- **Suspended Solids (SS):** These are the solids in raw water/wastewater that remain present on filter paper after filtering the sample through a fine filter.(Whatman's Filter paper No.42).The suspended solids contain much of the organic matter.
- **Dissolved Solids (DS):** The filtrate remaining in beaker after filtering the sample through filter contains dissolved solids. It includes mainly inorganic silt, small amount of organic matter and dissolved gases.
- **Fixed Solids:** The residue remain after the ignition of the sample in muffle furnace at 550^0C represents the fixed solids. These represent the organic matter in water.
- **Volatile Solids:** The difference between the suspended solids and fixed solids represent the amount of organic matter present in water.

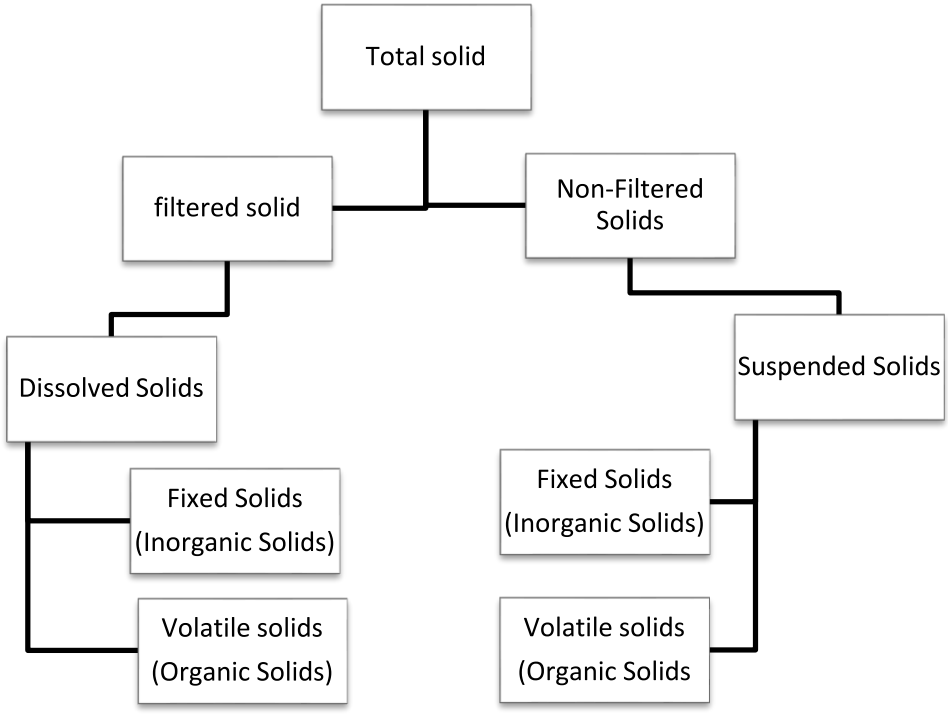

Figure 1: Classification of Total Solids

VIII. Experimental Set-up

Whatman's filter paper | Evaporating Dish | Hot Air Oven

Figure 2: Total Solids Set up

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Hot Air Oven	Electric Oven with digital control(Tempertature:300^0 C. 25 kg capacity)	1 No.	Per batch

2.	Evaporating Dish	Standard glassware beaker of 500 ml. capacity	3 Nos.	Per batch
3.	Filter Papers	Whatman's filter paper No.42	1 No.	Per batch
4.	Weighing Balance	Electronic weighing balance of accuracy 0.01 g	1 No.	Per batch

X. Procedure

- **For Total Solids:**
  1. Weigh the given clean and dry porcelain dish (A) and record its weight as (W_1) mg.
  2. Take a measured volume of wastewater sample in (A) – 25 ml. if the wastewater sample appears strong, 50 ml if it appears moderately strong and 100 ml. if it appears weak.
  3. Place the dish in hot-air oven.
  4. Evaporate to dryness in hot-air oven at 103^0C to 105^0C for about 24 hrs.
  5. Cool the porcelain dish to room temperature and weigh it as (W_2) mg.
- **For Dissolved Solids:**
  1. Weigh a clean and empty porcelain dish (B) and record its weight as (W_3) mg.
  2. Take a known volume of the sample, filter it through Whatman's filter paper No. 42 and collect the filtrate in (B).
  3. Evaporate the filtrate in (B) to dryness in a hot air oven at 103^0C to 105^0C
  4. Cool the porcelain dish to room temperature and weigh it as (W_4) mg.
- **For Suspended solids:**
  1. Take a Whatman's filter paper no. 42 and record its weight (W_3) gm.
  2. Filter 100 ml sample of wastewater by using above filter paper.
  3. Place the filter paper with residue in an oven and evaporate it to dryness.
  4. Read the weight of the filter paper and residue (W_4) gm.

XI. Precautions to be followed

1. Use clean and dry evaporating dish.
2. Take weight and record carefully.
3. Maintain temperature of oven as per requirement.
4. Record the temperature of room.
5. Record weight in steady condition.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

- **For Total Solids (TS)**

Sr. No	Source of Sample	Volume of Sample(mL)	Weight of dish (gm)		
			Initial (W_1)	Final (W_2)	Difference (W_2-W_1)

- **For Suspended Solids (SS)**

Sr. No	Source of Sample	Volume of Sample(mL)	Weight of dish (gm)		
			Initial (W_3)	Final (W_4)	Difference (W_4-W_3)

Sample Calculation:

1. **Concentration of Total Solids**,(mg/l) = $\frac{(W_2-W_1) \text{ X } 1000 \text{ X } 1000}{\text{Volume of Sample taken (ml)}}$

   = ----------

   = ----------mg/L

2. **Concentration of Total Suspended Solids**,(mg/L) = $\frac{(W_4-W_3) \text{ X } 1000 \text{ X } 1000}{\text{Volume of Sample in mL}}$

   = ----------

   = ----------mg/L

3. **Concentration of Total Dissolved Solids**,(mg/L) = (Conc. of TS) – (Conc. of SS)

   = ----------

   = ----------mg/L

XVI. Results

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XVII. Interpretation of results*(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the significance of concentration of solids from the point of view of strength of sewage.
2. Define “fixed” and “volatile” solids in wastewater?
3. Define “Setteleable” and Non-setteleable solids in wastewater?
4. Explain the necessity to determine the concentration of suspended solids in wastewater?
5. Give the effects of high concentration of dissolved solids in wastewater?
6. Explain the effects of solids in wastewater treatment.
7. Give the limits of the suspended solids for wastewater, if it is discharge into surface water and used for irrigation?
8. State the form of solid that is essential while designing the settling tank in wastewater treatment.
9. Suggest physical and chemical treatment for reducing TS,SS and TDS of wastewater.

Space to Write Answers

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XX. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaia h	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Recording of weight	20 %
2	Process with filtration and oven	20 %
3	Calculations from recorded weights	20 %
Product related:10 Marks		**40%**
3	Interpretation and Conclusion	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 13: Dissolved Oxygen in Wastewater

I. Practical Significance

Dissolved Oxygen determinations at various points along a river course are carried out to define the pollution status of the river. D.O. level of more than 3mg/l (or 40% saturation value) is desirable for the existence and growth of fish and such other forms of aquatic life. (It is usual to find D.O. in the range of 6 to 8 mg/l in normal flowing river water). D.O. measurements are important for maintaining aerobic conditions in aerobic biological treatment units. Determination of D.O. is the basis of the BOD test. D.O. levels are used to control corrosion of iron and steel in distribution systems and steam boilers.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and lifelong learning activities in the context of technological changes also in the Civil engineering and allied industry..*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and waste water.

IV. Practical Outcome:

To determine the dissolved oxygen in a sample of wastewater.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **"Determination of dissolved oxygen decides suitability of water for aquatic life, municipal drinking water supply and also for industrial processing. A low dissolved oxygen level indicates increase in pollution level.**

a. Determination of dissolved oxygen in waste water
b. Comparing two wastewater samples based on their DO content.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

The D.O. value varies with other parameters like temperature, pressure, chloride concentration. The solubility of free Oxygen decreases with increase in temperature, it ranges from 14.6 mg/l at 0°C to 7 mg/l at35°C at atmospheric pressure. D.O. also decreases with increase in chloride concentration.

The minimum D.O. required for survival of fish and other forms of aquatic animals is 4 mg/l. Addition of organic pollution leads to reduction in D.O. content due to consumption of oxygen by bacteria in decomposition and oxidation of the organic matter. In order to decompose all organic matter adequate amount of D.O. must be present in wastewater then the end products are stable and do not produces foul smell.

VIII. Experimental Set-up

Figure 1: Digital D.O. meter.

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	Digital DO meter	Range: 0 to 20 ppm, Resolution: 0.1 ppm, Temperature Compensation: 0 to 50 ^{0}C.	1 No.	Per batch
2.	Beaker	Standard glassware beaker of 500 ml. capacity	3 Nos.	Per batch

X. Procedure

1. Calibration Before measurement

- Disconnect the " OXYGEN PROBE plug " from the main instrument " Input socket “
- Power on the instrument by selects the “On/Off Switch “to the “On " position. Slide the “DO / CAL Switch “to the “CAL“position. Adjust the “ZERO Adj. VR “until the display shows zero value.
- Power off; connect the “OXYGEN PROBE plug “to the main instrument “Input Socket “then power on. Wait 5 minutes at least until the display reading values become stable & no fluctuation. Adjust the “CAL Adj. VR” until the display reading show the values exact same as 20.9 (As the oxygen in air is 20.9 % typically) (Calibration consideration : Please make calibration procedures under wide and ventilating environment for best effect.)

2. Dissolved Oxygen (DO) measurement

- After the meter be calibrated, don't adjust the " CAL Adj. VR " & " ZERO Adj. VR " again until next calibration procedures be done
- Slide the “DO / CAL Switch “to the “DO " position.
- Immersed the probe to a depth at least 10 cm of the measured liquid in order for the probe to be influenced by the temp. & automatic temperature compensation to take place. As for the thermal equilibrium to occur between the probe & the measurement sample must be allowed to pass, which usually amounts to a few minutes if the temp. Difference between the two is only several C degrees.
- In order to measure the dissolved oxygen content in any given liquid, it is sufficient to immerse the tip of the probe in the solution, making sure that velocity of the liquid coming into contact with the probe is at least 0.2 - 0.3 m/s or shake the probe. During laboratory measurements, the use of a magnetic agitator to ensure a certain velocity in the fluid is recommended. In this way, errors due to the diffusion of the oxygen present in the air in the solution are reducing to a minimum.

- Rinsed the probe accurately with normal tap water after each series of measurement.

XI. Precautions to be followed

1. Use clean and dry beakers.
2. The Standardization of DO meter is essential before use.
3. Clean and wipe out electrode every time of immersion.
4. Record the temperature of room.
5. Record the reading in steady condition.
6. The use of electrode should be done very carefully as it is very sensitive and breakable.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

Sr. No.	Particulars	Sample No.		Average D.O. (mg/l)
	Sample No.	1 (mg/l)	2 (mg/l)	
1	Domestic waste water			
2	Industrial waste water from any* specific industry e.g. i)Sugar Industry ii) Food & Beverages iii) Paint Industry etc.			
3	Stagnant surface water (i.e. pond)			

* Any specific industry in the area

Sample Calculation

For Observation No.…….

- Observed Average value of D.O. for Domestic waste water sample
  D.O. of sample No. (1) + D.O. of sample No. (2) / 2 = …….
- Observed Average value of D.O. for Industrial wastewater sample
  iv) D.O. of sample No. (1) + D.O. of sample No. (2)/ 2 = …….
  v) D.O. of sample No. (1) + D.O. of sample No. (2)/ 2 = …….
  vi) D.O. of sample No. (1) + D.O. of sample No. (2)/ 2 = …….
- Observed Average value of D.O. for Stagnant surface water (i.e. pond) water sample
  D.O. of sample No. (1) + D.O.of sample No. (2)/ 2 = …….

XVI. Results

The average value of D.O. for Domestic waste water sample is found to be ……..

The average value of D.O. for Industrial waste water sample from Sugar Industry is found to be …….

The average value of D.O. for Industrial waste water sample from Food & Beverages Industry is found to be ……

The average value of D.O. for Industrial waste water sample from paint Industry is found to be ……...

The average value of D.O. for Stagnant Surface waste water sample is found to be ……

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the exact location of wastewater sample taken for the testing purpose.
2. Give the reasons for variation in D.O. value of wastewater sample from various locations.
3. Justify the difference in D.O. values of wastewater sample tested.
4. Suggest the treatment for the wastewater to bring it to the acceptable limit for aquatic life, drinking water and industrial processing.
5. Justify for the difference in DO values of three types of samples taken for testing purpose
6. State the acceptable limit of D.O. value for the aquatic life to survive.

7. State the effect on D.O. values of wastewater with the passage of time after its generation.
8. State how D.O. value will affect the treatment process to be adopted for particular wastewater or sewage.
9. State how D.O. value will affect the other purification/treatment process at sewage treatment plant.
10. State various methods to find D.O. value of wastewater in a laboratory.
11. Give the specific pollutants responsible for reduction in D.O. value in wastewater.
12. State D.O. Fixation.

Space to Write Answers

XX. References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Calibration of the instrument	30 %
2	Operation of Instrument	30 %
Product related:10 Marks		**40%**
4	Interpretation and conclusion related to the test.	10%
5	Answers to practical related questions.	20%
6	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Name / Roll No.)

1. ……
2. ……
3. ……
4. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 14: Chemical Oxygen Demand In Wastewater

I. Practical Significance

Chemical Oxygen Demand (COD) is the oxygen required for the complete oxidation of biologically active as well as inactive organic matter/inorganic matter in reduced state by adding strong oxidizing reagents. COD is a measure of the total quantity of oxygen required for oxidation of nearly all organic compounds in wastewaters, by the action of a strong oxidizing agent. BOD is a measure of only the carbonaceous component of biodegradable organic matter in a waste, whereas COD measures nearly all the oxidizable matter in the waste. Therefore COD for a waste is greater than its BOD value. Both BOD and COD values of any waste are important parameters, as their inter-relationship decides the type of treatment to be adopted for the waste. If BOD/COD ratio is known for any particular waste, from COD values, we can predict BOD values. If COD is very much greater than BOD, then the waste is not biologically biodegradable. Biodegradability of the waste is indicated by the treatability index (TI)

$$TI = BOD / (COD – BOD)$$

TI less than 0.5 indicate that the waste is not amenable to biological treatment especially aerobic. Chemical treatment may be suggested. TI between 0.5 and 1.0 indicates that biological treatment for the waste may be considered with necessary nutrient supplementation. TI more than 1.0 indicates that the waste is amenable to biological treatment. All biodegradable wastes are chemically degradable. However, for any waste providing biological treatment should be first explored as it is more economical.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Life long learning: *Engage in independent and lifelong learning activities in the context of technological changes also in the Civil engineering and allied industry. .*

III. Relevant Course Outcomes

Identify the sources and characteristics of water and wastewater.

IV. Practical Outcome:

To determine the Chemical Oxygen Demand of sample of wastewater.

V. Competency and Practical Skills

This practical is expected to develop following skills for the industry identified competency **Determination of Chemical Oxygen Demand decides suitability of waste water for**

Deciding nearly all the content of oxidizable matter in the waste. Depending upon the treatability Index (TI), treatment to be given i.e. chemical or biological can be given to the waste water.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

COD or chemical oxygen demand is the oxygen required for the complete oxidation of biological degradable organic matter / in reduced state. It is determined to know the amount of oxygen required by the simple chemical oxidation of compounds.

It is a measure of amount of carbon in organic matter of sewage. It is useful in identifying the performance of the various steps of treatment plants. It is also useful in determining the strength of industrial waters in sewage, which cannot be determined by B.O.D. test. The limitation of this test is its inability to differentiate between the biologically oxidizable and biologically inert material. COD determination has an advantage over BOD determination that it takes only 5 hours as compared with BOD require 5 days. This test is also easy and also not affected by interferences as in BOD test.

VIII. Experimental Set-up

Figure 1: COD Reflux Apparatus

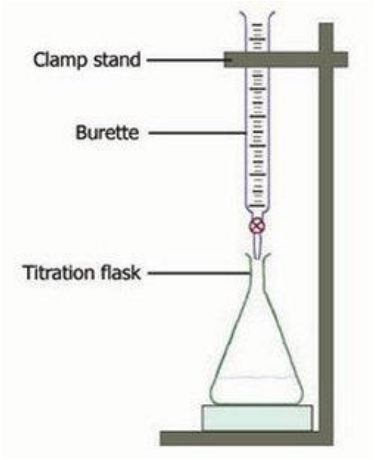

Figure 2 : Titration set

IX. Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1.	COD Reflux Apparatus	Temperature Range: Above amb. to180°C Resolution: 1°C, Display: Digital 12mm Red LED Control: Digital electronic Temp Controller. Heater rating : 750 Watts, Sensor: PT – 100 Timer : Selectable ,15,30,45,60,90 or 120min with alarm, Hole Size : 40mm Dia 80mm Depth Glass Tube : 38mm dia1 5 no's (5 X 3 rows) Sample Volume : 20ml each. Dimension : 500 W X 270 D X 210mm H	1 No.	Per batch
2.	Titration Set	Consisting of Stand, Beaker of requisite capacity, pipette	1 No.	Per batch
3	Hot Plate	Of requisite quality	1 No.	Per batch

X. Procedure

Reagent:

Standard potassium dichromate (0.250 N) ($K_2Cr_2O_7$), Sulphuric acid reagent, standard ferrous ammonium sulphate (0.25 N), Ferroin indicator, Mercuric sulphate ($HgSO_4$), Glass Bids

1) Standard potassium dichromate (0.250 N) – Dissolve 12.259 gm ($K_2Cr_2O_7$) dried at 103°C for 24 hours in distilled water and dilute to 1000 m. add about 120 mg sulphuric acid to take care of 6mg/l NO_2 –N
2) Sulphuric acid reagent – 10 gm of Ag_2SO_4 to 1000 ml concentrated H_2SO_4 and keep overnight for dissolution.
3) Standard ferrous ammonium sulphate 0.25 N – Dissolve 39 gm. Fe $(NH_4)_2(SO_4)_2$ and dilute to 1000 ml.
4) Ferroin indicator – Dissolve 1.485 gm 1.10 phenanthroline monohydrate and 695 mg $FeSO_4$ $7H_2O$ and dilute to 100 ml with distilled water.
5) Mercuric sulphate: $HgSO_4$ crystals.

Stepwise procedure:

1. Take 10 ml of sample into a round bottom reflex flask.
2. Add some glass beads to prevent the solution from bumping into the flask while heating.
3. Add 1 ml of mercury sulphate ($HgSO_4$) solution to the flask and mix by swirling the flask.
4. Add 5 ml of standard Potassium dichromate ($K_2Cr_2O_7$) solution.
5. Now add slowly and carefully 15 ml Silver sulphate-sulphuric acid solution.
6. Connect the reflux condenser and digest the content using a hot plate for 2 hours.
7. After digestion cools the flask and rinses the condenser with 25 ml of distilled water collecting in the same flask.
8. Add 2-4 drops of ferroin indicator to the flask and titrate with 0.025 M ferrous ammonium sulphate solution to the end point.
9. Make the blank preparation in the same manner as sample using distilled water instead of sample.

XI. Precautions to be followed

1. Use clean and dry Beakers, Burette, Pipette, Flask,
2. Proper reagents should be used.
3. Preparation of Dilution of sample should be done properly.
4. Determination of COD for the blank and sample should be done with due care.

XII. Actual procedure followed *(Use blank sheet if provided space is not sufficient)*

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XIII. Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					
4					

XIV. Precautions followed

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XV. Observations

Observation table for Chemical Oxygen Demand

For dilution factor (DF = ……..) ,

Sr. No.	Sample (Collection Sources)	ml of ferrous Ammonium sulphate		
		Flask 1	Flask 2	Flask 3
1	Blank			
2	Spent wash			
3	Domestic sewage			
4	Industrial Sewage			
5	Stagnant waste water			

Sample Calculation:

Calculate the chemical oxygen demand by the following formula

$$COD = \frac{8 \text{ X } 1000 \text{ X DF X M X (VB} - \text{ VS)}}{Volume\ of\ sample\ (in\ ml)}$$

Where , DF – Dilution factor (if applicable)

M – Molarity of standardized Ferrous Ammonium Sulphate solution.

VB – Volume consumed in titration with blank preparation.

VS – Volume consumed in titration with sample preparation.

XVI. Results

- COD of the given sample obtained from Domestic waste water is found to be …….
- COD of the given sample obtained from spent wash is found to be ……..
- COD of the given sample obtained from waste water from industry (any specific) is found to be ……...
- COD of the given sample obtained from stagnant surface waste water sample is found to be ……

XVII. Interpretation of results *(Give meaning of the above obtained results)*

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XVIII. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results)*

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XIX. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Define COD.
2. Define dilution factor.
3. Explain why BOD value is always less than COD value.
4. State the significance of COD in wastewater treatment.
5. Give comparison between BOD and COD test.
6. State the importance of BOD /COD ratio.
7. Give the time required for COD test.
8. State the correlation between COD value and organic matter of sample.
9. Name the chemical reagents used in COD test.
10. Write the value of COD for following industrial wastes
    a) Dairy b) Tannery c) Textile d) Distillery

Space to Write Answers

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XX. References / Suggestions for further Reading

S. No.	Title of Book	Author	Publication
1	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	Dhanpat Rai and Sons, 201ISBN: 81874337954,
3	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
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5	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60 %**
1	Calibration of the instrument	30 %
2	Operation of Instrument	30 %
Product related:10 Marks		**40 %**
4	Interpretation and conclusion related to the test.	10 %
5	Answers to practical related questions.	20 %
6	Submission of report in time.	10 %
Total: 25 Marks		**100 %**

List of Student Team Members (Name / Roll No.)

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 15: Wastewater Treatment Plant

I. Practical Significance

The treatment given to wastewater before discharging it to the disposal point is very essential i.e. complete process of removing objectionable impurities from it so that it will not pollute the receiving body or will not cause any kind of adverse effect on the surrounding environment.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Draw the flow diagram for process of treatment of water and wastewater.

IV. Practical Outcome:

To undertake field visit to conventional Wastewater Treatment Plant.

V. Competency and Practical Skills

This practical is expected to understand operation and maintenance of wastewater treatment plant. **"Study of different units and process of wastewater treatment executed at conventional wastewater treatment plant."**

a. Collection of information for technical report on Wastewater Treatment Plant
b. Preparing a report using different diagrams/sketches and collect the information related to various units, its dimensions/capacity etc.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

Wastewater treatment plant has different units through which wastewater gets treated in the successive order.

Process of treatment of waste water is

1. Screening
2. Grit removal
3. Skimming
4. Primary sedimentation of waste water
5. Aeration of waste water
6. Secondary Sedimentation
7. Sludge Digestion
8. Trickling Filter

VIII. Concept Structure

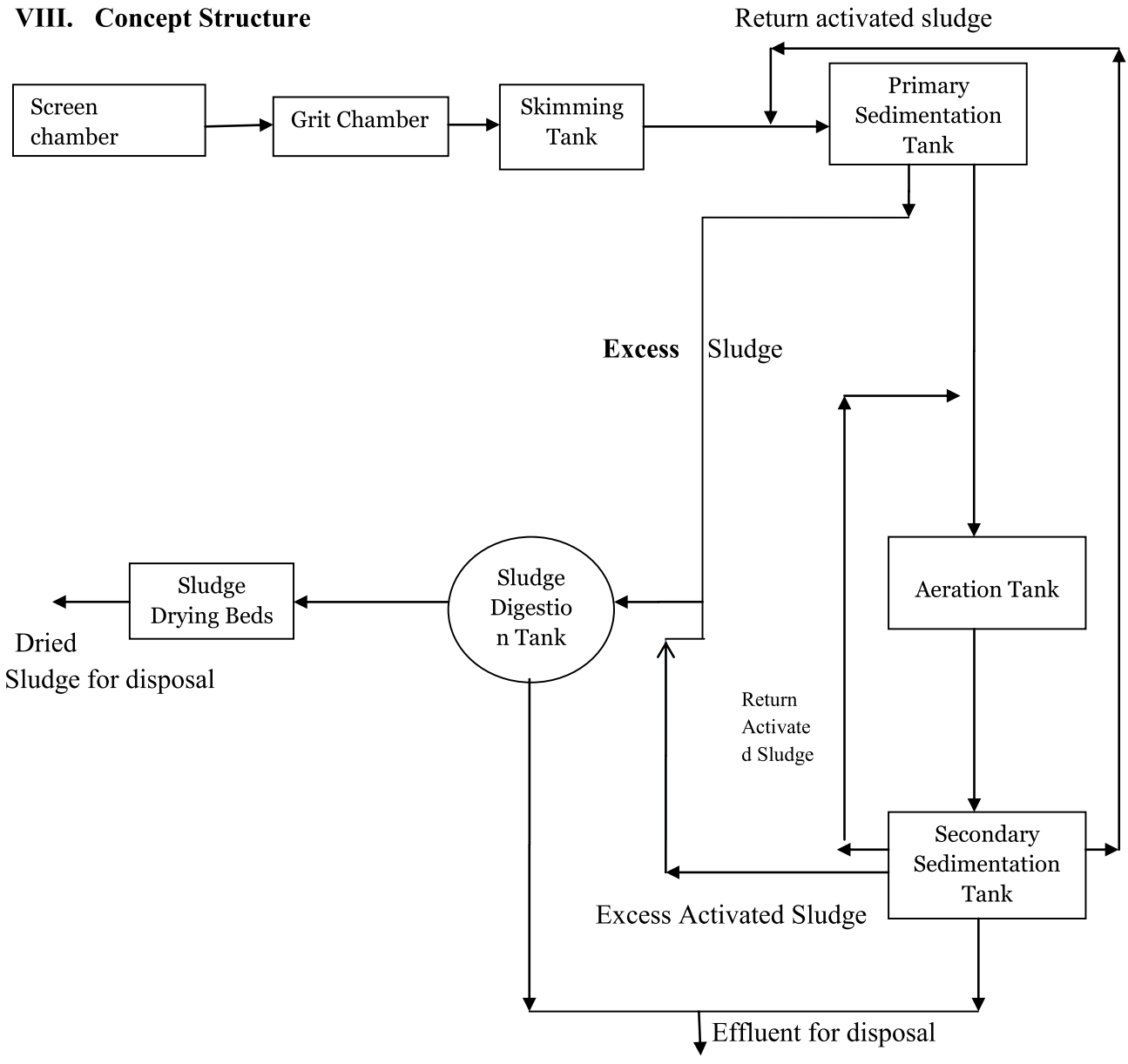

Figure 1: Flow diagram of Waste water treatment plant.

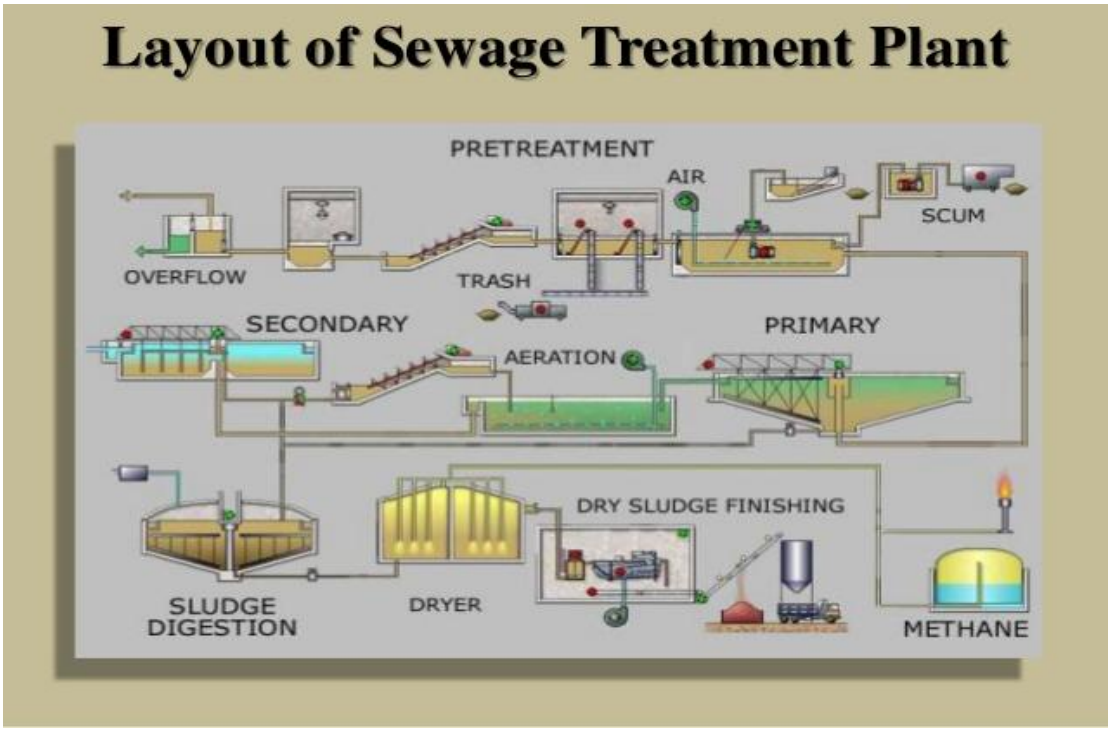

Figure 2: Layout of Waste Water treatment plant.

IX. Format of Visit

C. Date of Visit: ……

Place of Visit: ……..……

Address of Visit place: ……. ……

D. Information of Waste Water Treatment Plant

1. Governing body of Waste Water Treatment Plant

   ……

2. Daily waste water generated (m^3/day)……
3. Areas (Residential/Commercial) from where waste water coming to the Treatment plant…….
4. Out flow of plant……..
5. Intake wastewater characteristics…….

6. Daily out flow……..
7. List of various parts and their function……..
8. Frequency of suspended particles removed per day…….....
9. Removal of Oil and Grease from the waste water…….
10. Removal B.O. D. Value from the waste water……..
11. Dimensions of different units of waste water treatment plant.

    ……
12. Capacity of each of treatment unit…….

13. Details of Energy recovery units (if any) ……
14. Any other additional information……
15. Draw labeled sketch of Sludge Digester…….
16. Draw flow diagram of Waste water treatment plant …….....…

    ……..

X. Precautions to be followed

1. Take prior permission from concern authority well in advance.
2. Adopt Safety measures during the visit.
3. Maintain discipline during journey and at STP.
4. Record all necessary information in note book.
5. Wear college uniform, shoes, cap, dupatta, sun glass, mask during visit.
6. Keep safe distance from moving parts/machines at site.

XI. Actual Visit Report followed *(Use blank sheet if provided space is not sufficient)*

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XII. Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the necessity of treatment of waste water.
2. State different types of sewage from the community considering its nature.
3. State the exact treatment carried in Primary sedimentation tank and Secondary sedimentation tank.

4. Define Sewage, Sullage and Sewerage.
5. Enlist various unit of treatment at waste water treatment plant and state the functions of each unit.
6. State the purpose of providing sludge drying beds.
7. State about different types of screens provided in screen chamber.
8. Explain the activated sludge process.
9. Explain aerobic and anaerobic process of treatment of wastewater.
10. Define “Influent and Effluent”.

Space to Write Answers

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XIII. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
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5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XIV. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Punctuality for visit timings	30 %
2	Behavior at visit location	30 %

Product related:10 Marks		**40%**
3	Interpretation and report writing	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members (Roll No.)

1. ……
2. ……
3. ……
4. ……..

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 16: Visit to Gobar Gas / Bio Gas Plant

I. Practical Significance

Biogas development in the country has been receiving lot of attention as a powerful source of energy and fertilizer supply in the rural areas. Bio-gas plants in villages and towns are coming up at a fast rate. Most of these plants are installed on individual houses and farms and are of capacity 3-7cum. To encourage the production and use of bio-gas, the Ministry of Agriculture, Govt. of India has agreed to sanction 25% of the cost of gas plant as grant to individuals. Besides, for institutions and cooperative societies, capital assistance in the form of grant and loan, are available from the Khadi and Village Industries Commissions and the nationalized banks respectively. Further, to provide benefits to village as a whole, large community size bio-gas plants of capacity 140 cum. per day have been planned to be set up throughout the country.

Bio-gas contains 4500 to 6000 calories per cum; thus providing a convenient source of heat at low cost. One cum. Of the gas at 6000 calories, is equivalent to the following quantities of other fuels: 1.1 litres of alcohol; 0.8 litres of petrol; 0.6 litres of crude oil; 1.5m^3 of cooking gas;1.4 kg of charcoal and 2.2 KWH of electrical energy. Bio-gas can, therefore, be used as a source of energy for cooking, lighting, driving oil engines, pumping water for irrigation, running chaff cutters, floor mills and other rural industries. It is found that bio-gas using cattle dung alone can extract 3.5 times of useful energy from cattle dung of that derived by direct burning. It is estimated that of the total available cattle dung in Punjab state of .76 million tonnes per year, bio-gas production would be 1.66 billion cum. Per year, which has an electric power equivalent of 8.8 MW hours and kerosene equivalent of 1.09 billion tonnes per year. Besides, the manure produced as a bye-product would be 1.05 million tonnes having available nitrogen content of 1.5 lakh tonnes. All the aforesaid figures prove beyond doubt the immense potential of bio-gas as a source of energy.

II. Relevant Program Outcomes

PO 1. ***Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. ***Discipline knowledge****: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. ***Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

PO 10. Lifelong learning: *Engage in independent and life –long learning activities in the context of technological changes also in the Civil engineering and allied industry.*

III. Relevant Course Outcomes

Draw the flow diagram for process of treatment of water and wastewater.

IV. Practical Outcome:

To undertake field visit to Gobar / Bio Gas Plant.

V. Competency and Practical Skills

This practical is expected to understand Working , operation and maintenance of Gobar / Bio Gas Plant.**"Study of different components of Gobar / Bio Gas Plant and understanding the functional utility for the community".**

a. Collection of information for technical report on Gobar / Bio Gas Plant
b. Preparing a report using different diagrams/sketches and collect the information related to various components, its functions etc.

VI. Relevant Affective domain related

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as leader or a team leader.
d. Maintain tools and equipment.
e. Follow ethical practices

VII. Minimum Theoretical Background

The excremental matters of these all animals is mostly dried and used as fuel for kitchen. But in rainy season and some part of winter, when it is not possible to dry it, the cow and other animals droppings are disposed off in various ways without making any use of them. At some places these are utilized in the production of manure.

Nowadays the "Gobar Gas Plants" are becoming very popular in the villages for the production of Gobar gas from the animals droppings. A typical gobar gas plant essentially consists of a circular well shaped tank, divided in two compartments by one partitions wall. It is covered from top by a cylindrical dome, which collects the gas. Inlet is provided for feeding excremental matter and one outlet is provided through which digested sludge in the form of rich manure comes out.

The night soil from the water closet directly reaches in the digestion tank through pipes. The water is added in the animals dung to form a slurry of about 10% solids. This slurry is fed into digester through the inlet pipe.

The percentages of Nitrogen, Phosphorous and Potassium in the digested sludge are the same as those in the raw materials of night soil and cow dung.

Uses of Bio- Gas :

Besides its use for cooking, lighting and driving oil and gas engines, bio gas serves other purposes especially in rural areas. These include the following:

1) It makes an efficient use of the slurry produced after digestion in the gas plant. The slurry can be converted into a quick return compost without loss of soil nutrients viz. nitrogen, phosphorus and potash.
2) It ensures health of the rural folk by eliminating nuisance due to mosquitoes, flies and insects breeding on exposed cattle dung. It also promotes the well being of the house wives through prevention of eye diseases caused by burning cattle dung cakes in chullas.

VIII. Concept Structure

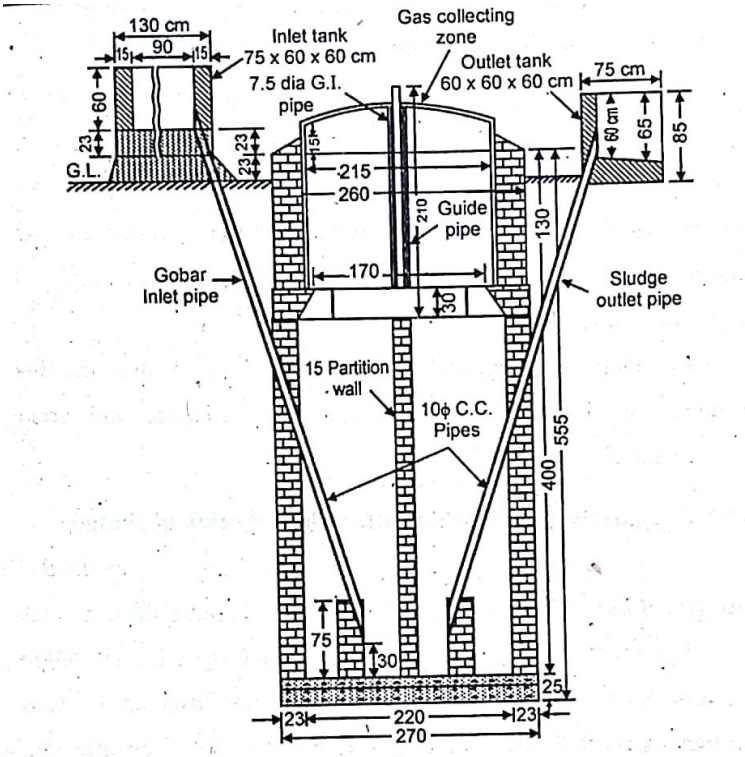

Figure 1: Gobar Gas Plant

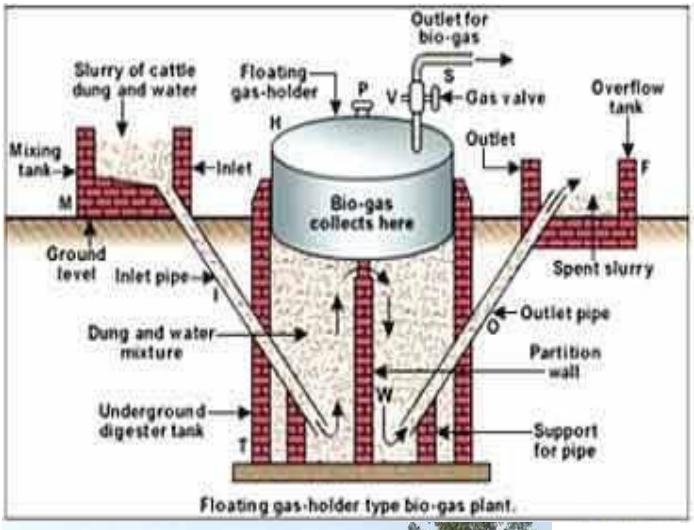

Figure 2: Image of gobar gas plant

IX. Format of Visit

A. Date of Visit: ……

Place of Visit: ……..…….

Address of Visit place:……. ……

B. Information of Gobar Gas Plant Plant /Bio Gas Plant

1. Governing body / Owner of Gobar Gas Plant Plant / Bio Gas Plant……
2. Daily raw waste (gobar slurry) intake (m^3/day)

…….……..

3. Areas (Residential/Commercial) from where raw waste material used for Gobar Gas Plant / Bio Gas Plant …….…….
4. Out flow of plant……
   Quantity of digested sludge(m^3/ day) ……..
   Approximate quantity of gas collected digested sludge(m^3/ day) …….
5. Dimensions of various components of Gobar Gas plant / Bio Gas Plant……
6. Functions of various components of Gobar Gas plant/ Bio Gas Plant
   …….……
7. Details of Energy recovery unit i.e. Gas collecting Dome ……
8. Any other additional information ……..
9. Draw labeled sketch of Gobar Gas Plant / Bio Gas Plant ……
   …….……..
10. Draw neat sketch of Gobar Gas plant/ Bio Gas Plant ……..……
    …….…….

X. Precautions to be followed

1. Adopt Safety measures during the visit
2. Understand Maharashtra Pollution Control Board (MPCB) norms for generation of Bio gas
3. Note down various instructions adopted during the operation and maintenance of Gobar Gas Plant.

XI. Actual Visit Report followed *(Use blank sheet if provided space is not sufficient)*

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XII. Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum Five questions.*

1. What do you mean by Gobar Gas?
2. How is Gobar Gas Plant useful in Agriculture?
3. Which gas is present in Gobar Gas?

4. Can bio gas replaces natural gas?
5. What is percentage of Methane in bio gas?
6. Is biogas environmentally friendly?
7. How long does the cow dung takes to produce the bio gas?
8. How we can optimize the production of bio gas?
9. What is the scope of commercial Bio gas plant in an Indian metro city?
10. How is bio gas plant useful for us?
11. Draw a neat sketch of “Gobar Gas Plant”.
12. State the two important bi- products of Gobar Gas Plant / Bio Gas Plant.
13. Explain the working of Gobar gas plant.
14. Enlist the construction features of Gobar gas plant / Bio gas plant.
15. How does the bio gas plant works?

Space to Write Answers

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XIII. References / Suggestions for further Reading

Sr. No.	Title of Book/website Links	Author	Publication
1.	Environmental Engineering Vol. I and Vol. II	S.K. Garg	*Khanna Publishers, New Delhi, 2017, ISBN*-10: 8174091203; *ISBN*-13: 978-8174091208 ...
2.	Water Supply and Sanitary Engineering	Birdie G. S. Birdie J. S.	DhanpatRai and Sons, 201ISBN: 81874337954,
3.	Environmental Pollution Control Engineering	C.S. Rao	New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354
4.	Environmental Engineering	George Tchobanoglous	Tata Mcgraw Hill Publishers, 2013, ISBN 9789351340263
5.	Energy Management and Conservation	K V Sharma, P Venkataseshaiah	I.K. International Publishing House Pvt. Ltd., 2011, ISBN 13: 9789381141298

XIV. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Punctuality for visit timings	30 %
2	Behavior at visit location	30 %
Product related:10 Marks		**40%**
3	Interpretation and report writing	10%
4	Answers to practical related questions.	20%
5	Submission of report in time.	10%
Total: 25 Marks		**100%**

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1. ……
2. ……
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Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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