Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY, BENGALURU

LABORATORY PLAN

Academic Year 2019-20

Program:	B E – Civil Engineering
Semester :	7
Course Code:	15CVL76
Course Title:	Environmental Engineering Laboratory
Credit / L-T-P:	2 / 0-0-2
Total Contact Hours:	42
Course Plan Author:	Priyankashri K N

INSTRUCTIONS TO TEACHERS

- Classroom / Lab activity shall be started after taking attendance.
- Attendance shall only be signed in the classroom by students.
- Three hours attendance should be given to each Lab.
- Use only Blue or Black Pen to fill the attendance.
- Attendance shall be updated on-line & status discussed in DUGC.
- No attendance should be added to late comers.
- Modification of any attendance, over writings, etc is strictly prohibited.
- Updated register is to be brought to every academic review meeting as per the COE.

Table of Contents

Note : Remove "Table of Content" before including in CP Book
Each Laboratory Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. LABORATORY INFORMATION

1. Laboratory Overview

Degree:	B.Tech	*Program:*	CV
Year / Semester :	3 / 7	*Academic Year:*	2019-20
Course Title:	Environmental Engineering laboratory	*Course Code:*	15CVL76
Credit / L-T-P:	2 / 0-0-3	*SEE Duration:*	180 Minutes
Total Contact Hours:	42 Hrs	*SEE Marks:*	80 Marks
CIA Marks:	20	*Assignment*	5/1 Experiment
Course Plan Author:	Priyankashri K N	*Sign*	Dt : 04-04-2019
Checked By:	Shiva Prasad D G	*Sign*	Dt :

2. Laboratory Content

Expt.	Title of the Experiments	Lab Hours	Concept	Blooms Level
1	Determination of pH, Acidity and Alkalinity	02	pH, Acidity and Alkalinity	L3 Apply
2	Determination of Calcium, Magnesium and Total Hardness.	02	Calcium, Magnesium and Total Hardness.	L3 Apply
3	Determination of Dissolved Oxygen. Determination of BOD	02	Dissolved Oxygen.BOD	L3 Apply
4	Determination of Chlorides	01	Chlorides	L3 Apply
5	Determination of percentage of available chlorine in bleaching powder,	02	available chlorine	L3 Apply
6	Determination of Residual Chlorine		Residual Chlorine	L3 Apply
7	Determination of Solids in Sewage: I) Total Solids, II) Suspended Solids, III) Dissolved Solids,Volatile Solids, Fixed Solids, V) Settle able Solids.	02	Total Solids,	L3 Apply
8	Determination of Turbidity by Nephelometer	02	Turbidity	L3 Apply
9	Determination of Optimum Dosage of Alum using Jar test apparatus.	02	Optimum Dosage of Alum	L3 Apply
10	Determination of sodium and potassium using flame photometer.	01	sodium and potassium	L3 Apply
11	Determination Nitrates by spectrophotometer.	01	Nitrates	L3 Apply
12	Determination of Iron & Manganese	01	Iron & Manganese	L3 Apply
13	Determination of COD	Demonstration	COD	L2 Undestand
14	Air Quality Monitoring (Ambient, stack monitoring , Indoor air	Demonstration	Air Quality	L2 Undestand
15	Determination of Sound by Sound level meter at different location	Demonstration	Sound	L2 Undestand

3. Laboratory Material

Books & other material as recommended by university (A, B) and additional resources used by Laboratory teacher (C).

Expt.	Details	Expt. in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1	Text books		In Lib / In Dept
	S.K.Garg, "Water Supply Engineering", Khanna Publishers. 2010 T2 B.C Punmia, "Water Supply Engineering", Laxmi Publications Pvt. Ltd.,	In Lib	In Lib/ In dept
	"Standard methods for the examination of water and wastewater" 1995, ALPHA, AWWA, WPCF Publication		-
2	Reference books		In Lib
	"Chemistry for Environmental Engineering"- Sawer and McCarty, McGraw Hill.	In dept	Not Available
	R3 "Manual of standards of quality for Drinking Water Supplies"- Indian Council of Medical Research, New Delhi.		
	"International Standards of Drinking Water" – W.H.O.		-
	"IS 2490-1981, IS 3306- 1974, IS 3307-1977, IS 7968-1976, IS 2296-1974, IS 10500- 1991" Bureau of Indian Standards, New Delhi, Effluent Standard KSPCB		
3	Others (Web, Video, Simulation, Notes etc.)		
D	**Software Tools for Design**	**-**	**-**
E	**Recent Developments for Research**	**-**	**-**
F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**

4. Laboratory Prerequisites:

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.
Students must have learnt the following Courses / Topics with described Content . . .

Expt.	Lab. Code	Lab. Name	Topic / Description	Sem	Remarks	Blooms Level
1	15CHE17	ENGINEERING CHEMISTRY	Basic concepts of chemical reactions and mass balance	01		L3
2						
3						
5						
-						
-						

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.
Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Expt.	Topic / Description	Area	Remarks	Blooms

				Level
1	Knowledge of BOD, COD, Spectrophotometry	Higher Study	-	Understand L2
5				
-				

B. Laboratory Instructions

1. General Instructions

SNo	Instructions	Remarks
1	Observation book and Lab record are compulsory.	
2	Students should report to the concerned lab as per the time table.	
3	After completion of the program, certification of the concerned staff in-charge in the observation book is necessary.	
4	Student should bring a notebook of 100 pages and should enter the readings /observations into the notebook while performing the experiment.	
5	The record of observations along with the detailed experimental procedure of the experiment in the Immediate last session should be submitted and certified staff member in-charge.	
6	Should attempt all problems / assignments given in the list session wise.	
7	It is responsibility to create a separate directory to store all the programs, so that nobody else can read or copy.	
8	When the experiment is completed, should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.	
9	Any damage of the equipment or burn-out components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year	
10	Completed lab assignments should be submitted in the form of a Lab Record in which you have to write the algorithm, program code along with comments and output for various inputs given	

2. Laboratory Specific Instructions

SNo	Specific Instructions	Remarks
1	Students must wear Shoes and Aprons in the Lab	
2	Students must know Do's & Don't's of the Laboratory	
3	Handle chemicals and Glasswares with care	
4	Clean working tables neatly after using	
5	Before conducting any test, students shall come prepared with theoretical background of the corresponding test (indicated under the section'theory' in each test).	
6	Students shall make sure to have the knowledge of using weighing balance ,oven.	
7	Students shall give importance to accuracy and precision while conducting the test and interpreting the results	
8	Students shall acquaint themselves with the safe and correct usage of instruments / equipment's glassware chemicals acids under the guidance of teaching / supporting staff of the laboratory	

C. OBE PARAMETERS

1. Laboratory Outcomes

Expt.	Lab Code #	COs / Experiment Outcome	Teach.	Concept	Instr	Assessment	Blooms'

			Hours		Method	Method	Level
-	-	**At the end of the experiment, the student should be able to . . .**	-	-	-	-	-
1	15CVL76.1	The students will be able to understand the importance of water quality standards	02	Quality standards	Lecture and demonstration	C.IA	L3 Apply
2	15CVL76.2	The student will be able to analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity	02	pH, Acidity and Alkalinity	Lecture and demonstration	C.IA	L3 Apply
3	15CVL76.3	The student will be able to analyse the physical characteristics viz. colour, turbidity, and Hardness of a given water sample	02	Calcium, Magnesium and Total Hardness.	Lecture and demonstration	C.IA	L3 Apply
4	15CVL76.4	The student will be able to analyse the Dissolved oxygen and biochemical oxygen demand in water and waste water	02	Dissolved Oxygen.BOD	Lecture and demonstration	C.IA	L3 Apply
5	15CVL76.5	The student will be able to determine the chlorides in the given sample	02	Chlorides	Lecture and demonstration	C.IA	L3 Apply
6	15CVL76.6	To analyse the chemical characteristics of a given water sample viz. chlorides, Available Chlorine, residual chlorine content and turbidity to assess its suitability for drinking purposes	02	available chlorine, Residual Chlorine	Lecture and demonstration	C.IA	L3 Apply
7	15CVL76.7	The student will be able to determine the optimum dosage of alum using Jar test	02	Turbidity, Optimum Dosage of Alum	Lecture and demonstration	C.IA	L3 Apply
8	15CVL76.8	To analyse the chemical characteristics of a given water sample viz. Sodium and pottasium, Iron, nitrates, manganese content to assess its suitability for drinking purposes	02	sodium and potassium ,Iron,manganese	Lecture and demonstration	C.IA	L3 Apply
9	15CVL76.9	The student will be able to understand the Chemical Oxygen Demand in waste water	02	COD	Lecture and demonstration	C.IA	L3 Apply
10	15CVL76.10	The student will be able to understand the Air quality Monitoring and sound level	02	Air quality, sound	Lecture and demonstration	C.IA	L2 Understand
		Total	**36**		**-**	**-**	**-**

Note: Identify a max of 2 Concepts per unit. Write 1 CO per concept.

2. Laboratory Applications

Expt.	Application Area	CO	Level
1	Evaluate physical and chemical biological characteristics of water and waste water	CO1	L3
2	Measure quality of water	CO2	L3
3	To provide safe and portable water to public	CO3	L3
4	Determination of physical characteristics of water	CO4	L3
5	Determination of chemical characteristics of water	CO5	L3
6	Determination of Biological characteristics of water	CO6	L3
7	To check concentration of chlorine sodium potassium iron and manganese levels	CO7	L3

	in water		
8	Ability to find concentration of chemical oxygen demand in waste water	CO8	L3
9	Air quality monitoring	CO9	L2
10	Measure noise pollution	CO10	L2

Note: Write 1 or 2 applications per CO.

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Expt.	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
	CO1	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals inferring the quality of water	L2
	CO1	PO2	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals for dissolved oxygen content in water	L3
	CO2	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals for finding out chemical parameters like pH, acidity, alkalinity	L6
	CO2	PO2	L3	The students will be able to identify, formulate, review research literature, and analyse pH, acidity, alkalinity using Indian standard methods in reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	L2
	CO2	PO3	L3	The students will be able to design solutions for making the pH, acidity, alkalinity within the standard levels	L3
	CO3	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals for finding out the physical characteristics viz. colour, turbidity, and conductivity of a given water sample	L6
	CO3	PO2	L3	The students will be able to identify and examine physical characteristics viz. colour, turbidity, and conductivity of a given water sample using natural sciences, and engineering sciences	L2
	CO4	PO2	L3	The students will be able to identify, formulate and review research literature for dissolved oxygen content in water reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	L2
	CO4	PO4	L3	The students will be able to use research-based knowledge and research methods including design of experiments, analysis and interpretation of dissolved oxygen content	L3
	CO5	PO2	L3	The students will be able to identify, formulate and review research literature for chloride content in water reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	L6
	CO5	PO4	L3	The students will be able to use research-based knowledge and research methods including design of experiments, analysis and interpretation of chlorides content	L2
	CO6	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals to examine the chemical characteristics viz. chlorides, Iron, Available Chlorine and sulphates content to assess its suitability for drinking purposes.	L2
	CO6	PO2	L3	The students will be able to identify, formulate, review research literature, and analyse chemical characteristics viz. chlorides, Iron, Available Chlorine and sulphates content in samples	L3
	CO7	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to find the optimum dosage of alum using Jar test	L6
	CO7	PO2	L3	The students will be able to identify, formulate, review research literature, and analyse the optimum dosage of alum using Jar test reaching	L2

				substantiated conclusions natural sciences, and engineering sciences	
	CO8	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals to examine the chemical characteristics viz. chlorides, sodium potassium, Iron, nitrates, manganese content to assess its suitability for drinking purposes.	L2
	CO8	PO2	L3	The students will be able to identify, formulate, review research literature, and analyse chemical characteristics viz. sodium, potassium, Iron, nitrates, manganese content in samples	L3
	CO9	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals to understand the COD to assess its suitability for drinking purposes.	L6
	CO10	PO1	L3	The students will be able to apply the knowledge of mathematics, science, engineering fundamentals to understand the Air quality Monitoring and sound levels	L2

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Experiment Outcomes	Program Outcomes														-
Expt.	CO.#	**At the end of the experiment student should be able to . . .**	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	Level
1	15CVL76.1	The students will be able to understand the importance of water quality standards	2	3	-	-	-	-	-	-	-	-	-	-				L2
1	15CVL76.2	The student will be able to analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity	3	2	1	-	-	-	-	-	-	-	-	-				L2
2	15CVL76.3	The student will be able to analyse the physical characteristics viz. colour, turbidity, and Hardness of a given water sample	3	2	3	-	-	-	-	-	-	-	-	-				L2
2	15CVL76.4	The student will be able to analyse the Dissolved oxygen and biochemical oxygen demand in water and waste water	3	3	3	-	-	-	-	-	-	-	-	-				L3
3	15CVL76.5	The student will be able to determine the chlorides in the given sample	3	2		-	-	-	-	-	-	-	-	-				L2
3	15CVL76.6	To analyse the chemical characteristics of a given water sample viz. chlorides, Available Chlorine, residual chlorine content and turbidity to assess its suitability for drinking purposes	3	2		-	-	-	-	-	-	-	-	-				L3
4	15CVL76.7	The student will be able to determine the optimum dosage of alum using Jar test	3	2		-	-	-	-	-	-	-	-	-				L3
4	15CVL76.8	To analyse the chemical characteristics of a given water sample viz. Sodium and pottasium, Iron, nitrates, manganese content to assess its suitability for drinking purposes	3	2		-	-	-	-	-	-	-	-	-				L3
5	15CVL76.9	The student will be able to understand the Chemical Oxygen Demand in waste water	3	2		-	-	-	-	-	-	-	-	-				L2

5	15CVL76.10	The student will be able to understand the Air quality Monitoring and sound level	1	2		-	-	-	-	-	-	-	-	-				L2
-	15CVL76	**Average attainment (1, 2, or 3)**	**2.8**	**2.5**	**2.8**													-
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

5. Curricular Gap and Experiments

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

Note: Write Gap topics from A.4 and add others also.

6. Experiments Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

D. COURSE ASSESSMENT

1. Laboratory Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Unit	Title	Teaching Hours	No. of question in Exam							CO	Levels
			CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
1	Determination of pH, Acidity and Alkalinity	06	1	-	-	-	-	-	1	CO1	L3
2	Determination of Calcium, Magnesium and Total Hardness.	03	1	-	-	-	-	-	1	CO2	L3

3	Determination of Dissolved Oxygen BOD	03	1	-	-	-	-	-	1	CO3	L3
4	Determination of Chlorides	03	-	1	-	-	-	-	1	CO4	L3
5	Determination of percentage of available chlorine and residual chlorine	03	-	1	-	-	-	-	1	CO5	L3
6	Determination of Solids in Sewage:	03	-	1	-	-	-	-	1	CO6	L3
7	Determination of sodium and potassium using flame photometer.	09	-	-	1	-	-	-	1	CO7	L3
8	Determination Nitrates, sodium by spectrophotometer.	03	-	-	1	-	-	-	1	CO8	L3
9	Determination of COD.	03	-	-	1	-	-	-	1	CO9	L3
10	Air Quality Monitoring	06	-	-	-	-	-	-	1	CO10	L2
-	**Total**	**42**	**3**	**3**	**3**	**-**	**-**	**-**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	15	CO1, CO2, CO3	L3,L3,L3
CIA Exam – 2	15	CO4 ,CO5, CO6	L3,L3,L3
CIA Exam – 3	15	CO7 ,CO8, CO9	L3,L3,L3
Assignment - 1	05	CO1, CO2, CO3	L3,L3,L3
Assignment - 2	05	CO4 ,CO5, CO6	L3,L3,L3
Assignment - 3	05	CO7 ,CO8, CO9	L3,L3,L3
Seminar - 1	-		
Seminar - 2	-		
Seminar - 3	-		
	-		
Other Activities – define – Slip test		CO1 to Co9	L2, L3, L4 . ..
Final CIA Marks	**20**	**-**	**-**

-

SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	05 Marks
2	Record Writing	10 Marks for each Expt
3	Internal Exam Assessment	20 Marks
4	Internal Assessment	40 Marks
5	SEE	80 Marks
-	**Total**	**100 Marks**

E. EXPERIMENTS

Experiment 01 : Determination of pH, Acidity and Alkalinity

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	To measure the pH of the water using pH meter						
2	Course Outcomes	student will be able to analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity						

<table>
<tr><td>3</td><td>Aim</td><td>To measure the pH of the given sample</td></tr>
<tr><td>4</td><td>Material / Equipment Required</td><td>• Digital pH meter and beakers (250ml)
• Distilled water Buffer solutions pH-4,
• pH-7 and pH-9·2</td></tr>
<tr><td>5</td><td>Theory, Formula, Principle, Concept</td><td>Measurement of pH is one of the most important and frequently used tests in water analysis. Practically, every phase of water supply and waste water treatment, e.g. acid base, neutralization, water softening, precipitation, coagulation, disaffection and corrosion control is pH dependent. More – over many chemical and biochemical reactions are depending upon pH.
pH of a solution is defined as the negative logarithm (to the base 10) of hydrogen ion concentration. It may be mathematically stated as
$pH= -\log_{10} [H^+]$Similarly, pH of a solution is defined as
$pOH= -\log_{10} [OH^-]$</td></tr>
<tr><td>6</td><td>Procedure</td><td>A) <u>Instrument calibration:</u>
Connect the three pin plug to 230 V mains. Remove the electrode from storage solution and rinse with distilled water. Dry the electrode gently, blotting with a soft tissue paper. Take the buffer solution in a clean glass beaker. Dip the electrode in the solution and set the temperature of the solution using “temperature C knob”. Adjust ‘standardize’ knob so that the display reads the exact the value of the buffer solution. Standardize the instrument with electrode immersed in a buffer solution, within 2 pH units of sample ph. Remove the electrode from a buffer solution, rinse thoroughly with distilled water and finally dry it. Immerse the electrode in another buffer solution, having the pH 2 units higher than that of the experimental solution. Now the reading should be within 0.1 units for the pH of the second buffer. Otherwise, look for trouble with the electrode; switch off the instrument when not in use.
<u>Sample analysis :</u>
Now, immerse the electrode in a solution of unknown pH, taken in a beaker. Establish the equilibrium between the electrode and sample. By stirring the sample to ensure homogeneity (1 min). Switch on the instrument and read the pH. Again immerse in a fresh portion of the same sample and read the pH. In this pH meter, pH scale may be read off either in pH numbers or in mili volts for which a separate arrangement has been kept.</td></tr>
<tr><td>7</td><td>Diagram</td><td></td></tr>
<tr><td>8</td><td>Observation Table</td><td>
<table>
<tr><td>Sl.No</td><td>PH value by paper method</td><td>PH value by instrument method</td></tr>
<tr><td>Sample 1</td><td></td><td></td></tr>
<tr><td>Sample 2</td><td></td><td></td></tr>
</table>
</td></tr>
</table>

9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	-pH of the given sample of water = Sample No. 1 = Sample No.2 =
12	Application Areas	Evaluate chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Acidity of the given sample						
2	Course Outcomes	student will be able to analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity						
3	Aim	Determination of Acidity of the given sample						
4	Material / Equipment Required	• Burette • Conical flask • Pipettes .						
5	Theory, Formula, Principle, Concept							
6	Procedure	• Take 100 ml of the given sample in a conical flask. • Add 1 drop of 0.1N sodium thiosulphate solution to remove the residual chlorine if present. • Add 2 drops of Methyl orange, the sample turns pink. • Proceed with titration until the colour changes to yellow. • Note down the volume of the NaOH added (V_1). • Take another conical flask containing 100ml of water sample, add 2 or 3 drops of phenolphthalein. • Proceed with titration until the sample turns pink. • Note down the total volume of NaOH added (V_2).						
7	Diagram							
8	Observation Table							

Sample details	Volume of the sample (ml)	Methyl orange indicator			Phenolphthalein indicator		
		Initial	Final	NaOH used (ml)	Initial Final	Final	NaOH used (ml)

9	Sample Calculations	Mineral acidity due to mineral acids (as CaCO3) (mg/l) = (V_1 x 1000)/ml of sample taken CO_2 acidity due to CO_2 (as CaCO3) (mg/l) = (V_2 x 1000/ml of sampltaken
10	Graphs, Outputs	• - • -
11	Results & Analysis	Mineral acidity (mg/l) = CO_2 acidity (mg/l) = Total acidity as ($CaCO_3$) = Mineral acidity + CO_2 acidity. •
12	Application Areas	Evaluate chemical characteristics of water sample
13	Remarks	
14	Faculty Signature with Date	

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Alkalinity of the given sample						
2	Course Outcomes	student will be able to analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity						
3	Aim	Determination of Alkalinity of given sample						
4	Material / Equipment Required	• Burette • Conical flask • Pipettes .						
5	Theory, Formula, Principle, Concept							
6	Procedure	• Take 100 ml of the given sample in a conical flask. • Add 1 drop of 0.1N sodium thiosulphate solution to remove the residual chlorine if present. • Add 2 drops of Methyl orange, the sample turns pink. • Proceed with titration until the colour changes to yellow. • Note down the volume of the H_2so_4 added (V_1). • Take another conical flask containing 100ml of water sample, add 2 or 3 drops of phenolphthalein. • Proceed with titration until the sample turns pink. • Note down the total volume of NaOH added (V_2).						
7	Diagram							
8	Observation Table							

Sample details	Volume of the sample (ml)	Methyl orange indicator			Phenolphthalein indicator		
		Initial	Final	H_2so_4 used	Initial Final	Final	H_2so_4 used

						(ml)			(ml)

9	Sample Calculations	1) Phenolphthalein alkalinity (P) mg/lit as CaCO3 $P = V_1 \times \frac{\text{Normality of } H_2SO_4 \times 1000 \times 50}{\text{Vol of sample taken}}$ 2) Total alkalinity (T) mg/lit as $CaCO_3$ $T = V_2 \times \frac{\text{Normality of } H_2SO_4 \times 1000 \times 50}{\text{Vol of sample taken}}$ **For tap water** 1) Phenolphthalein alkalinity (P)=_____ mg/l as $CaCO_3$ 2) Total alkalinity (T) =_____ mg/l as $CaCO_3$. **TAP WATER**: 1) Phenolphthalein alkalinity (P) =_____ mg/l as CaCO3 2) Total alkalinity (T) =_____ mg/l as $CaCO_3$ **BORE WATER:** 1) Phenolphthalein alkalinity (P) =____ g/l as $CaCO_3$ 2) Total alkalinity (T) =_____ mg/l as $CaCO_3$
10	Graphs, Outputs	• - • -
11	Results & Analysis	1)Phenolphthalein alkalinity (P)=_____ mg/l $CaCO_3$ 2)Total alkalinity (T) =_____ mg/l as $CaOC_3$
12	Application Areas	Evaluate chemical characteristics of water sample
13	Remarks	
14	Faculty Signature with Date	

Experiment 02 : DETERMINATION OF TOTAL HARDNESS OF WATER SAMPLE

-	**Experiment No.:**	2	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Total Hardness						
2	Course Outcomes	student will be able to analyse the chemical characteristics of a given water sample viz. Total hardness, calcium and magnesium hardness						
3	Aim	To determine the Total Hardness of the given sample						
4	Material / Equipment Required	• Lab Manual • Burette, conical flask, pipette • Ammonia buffer solution • Erichrome black T indicator						

		• Standard EDTA solution as titrate (0.1M)
5	Theory, Formula, Principle, Concept	Hardness in water is that characteristics which prevents the formation of sufficient lather or foam, when such hardness are mixed with soap. Hardness is a measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatly acids from soap solutions. Hardness is defined as the characteristics of water which represents the total concentration of calcium and magnesium ions expressed as $CaCO_3$ and hence hardness is always reported as molar equivalent of $CaCO_3$ in mg/lt. Hardness of water is not a specific element but variable accounted by a complex mixture of cat ions and anions
6	Procedure,	**PROCEDURE:** **1) TOTAL HARDNESS** • Total 100ml of sample in a clean conical flask. • Add 1ml of ammonia buffer solution. • Add 1 pinch of Erichrome black-T indicator colour of the solution turns to wine red.Titrate against std EDTA solution till the colour changes to wine red to clear blue note down the burette reading (A-B). Total hardness in mg/lit as caco3 = ((A-B)×1000)/ (ml of sample taken). **2) PERMANENT HARDNESS** • Boil the sample continuously until all the co_2 gets expelled from the surface. • Cool the sample. • Take 100ml of sample in a clean conical flask. • Add 1ml of ammonia buffer solution. • Add 1 pinch of Erichrome black-T indicator colour of the solution turns wine red. • Titrate against std EDTA solution till the colour changes to wine red to clear blue note down the burette reading (A-B). • Permanent hardness in mg/lit as $CaCO_3$ = ((A-B)×1000)/ (ml of sample taken).
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table,	**1) TOTAL HARDNESS:**

Total hardness in mg/l as $CaCO_3$ = ((A-B)×1000)/ (ml of sample

Sl no	Sample	Burette reading			Total hardness in mg/l as $CaCO_3$
		Initial reading	Final reading	ml of std EDTA used	

Sl no	Sample	Burette reading			permanant hardness in mg/l as $CaCO_3$
		Initial reading	Final reading	ml of std EDTA used	

Permanent hardness in mg/lit as $CaCO_3$ = ((A-B)×1000)/ (ml of sample)
= _____mg/l as $CaCO_3$

Temporary hardness = total hardness – permanent hardness
= _____mg/l as $CaCO_3$

9	Sample Calculations	Total hardness in mg/l as $caco_3$ = ((A-B)×1000)/ (ml of sample) • = _____ as $CaCO_3$. • Permanent hardness in mg/lit as CaCO3 = ((A-B)×1000)/ (ml of sample) = _____mg/l as $CaCO_3$

		Temporary hardness = total hardness – permanent hardness = _____mg/l as $CaCO_3$
10	Graphs, Outputs	
11	Results & Analysis	• Total hardness of given sample = _____mg/l as $CaCO_3$ • Permanent hardness of given sample= _____mg/l as $CaCO_3$ • Temporary hardness of given sample= _____mg/l as $CaCO_3$
12	Application Areas	Analysis of water auality
13	Remarks	
14	Faculty Signature with Date	

-	**Experiment No.:**	2	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	CALCIUM AND MAGNESIUM HARDNESS						
2	Course Outcomes	student will be able to analyse the chemical characteristics of a given water sample viz. Total hardness, calcium and magnesium hardness						
3	Aim	To determine the calcium and magnesium hardness of given water sample.						
4	Material / Equipment Required	• Lab Manual • Burette, conical flask, pipette • Ammonia buffer solution • Erichrome black T indicator • Standard EDTA solution as titrate (0.1M)						
5	Theory, Formula, Principle, Concept	Under highly alkaline condition (pH=12-13), Magnesium precipitates as magnesium hydroxide and calcium forms complexes with EDTA in presence of indicator which combines with calcium only						
6	Procedure	**CALCIUM HARDNESS:** • Take 100ml of water sample in a clean conical flask. • Add 1ml of 1N NaOH solution into the sample. • Add 1 pinch of Patten and Reeder's indicator into the solution. Colour of the solution turns to wine red. • Titrate it against Std. EDTA till the colour changes from wine red to clear blue. Note down the burette reading (A-B) • Calcium hardness in mg/l as $CaCO_3$ = (A-B)×1000/ml of sample taken • Magnesium hardness in mg/l as $CaCO_3$ = Total hardness – Calcium hardness						
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							
8	Observation Table							

		<table><tr><td rowspan="2">Sl no.</td><td colspan="2">Burette reading</td><td>Calcium hardness</td><td>magnesium hardness</td></tr><tr><td>IR</td><td>FR</td><td></td><td></td></tr><tr><td>1</td><td></td><td></td><td></td><td></td></tr><tr><td>2</td><td></td><td></td><td></td><td></td></tr></table>
9	Sample Calculations	• Calcium hardness of given sample = • Magnesium hardness of given sample =
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	To check quality of water
13	Remarks	
14	Faculty Signature with Date	

Experiment 03 : DISSOLVED OXYGEN TEST BY WINKLER'S METHOD OR MODIFIED AZIDE METHOD

-	**Experiment No.:**	3	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	DISSOLVED OXYGEN						
2	Course Outcomes	Students are able to determine Dissolved oxygen in a given sample						
3	Aim	To find the quantity of dissolved oxygen present in the given sample						
4	Material / Equipment Required	• Manganese sulphate • Alkali iodide Azide reagent • Starch indicator • Concentrated sulphuric acid • Standard sodium Thiosulphate (0.025N)						
5	Theory, Formula, Principle, Concept	Oxygen present in sample oxidizes the divalent manganese to its higher valiancy which precipitates as a brown hydrated oxide after addition of NaOH and K of upon acidification manganese reacts to divalent static acid liberates iodine from K equivalent to BOD content in the sample. The liberated iodine is titrated against $Na_2S_2O_3$ (0.025N) using starch as indicator. If oxygen absents in sample the $MnSO_4$ reacts with alkali to form white precipitate $Mn(OH)_2$.						
6	Procedure	• Take a clean and dry BOD bottle and collect 300ml of water sample in it. • Tap the neck sample of the BOD bottle to expel air bubble if any. • Add 2ml of manganese sulphate and 2ml of alkali iodide azide solution to the BOD bottle. The tap water of the pipette should be below the liquid level while adding the above said solution. • Re-stopper with care to exclude air bubble. • Mix the content properly by repeatedly inverting the bubble 10-15 times. • If oxygen is present then the manganese ion gets converted into a brown colour manganese oxide (MnO_3). After taking and allowing sufficient limit for all oxygen to react, the chemical ppt is allowed to settle thereby having a clear liquid at the top portion.						

<table>
<tr><td></td><td></td><td>

A 2ml of conc. sulphuric acid and mix the sample completely by re-stopping the bottle and inverting it.
A dark yellow colour solution is obtained which is immediately titrated against sodium this sulphate solution by taking 203ml in a conical flask until the colour changes to pale yellow (strew yellow).
Now add starch as an indicator, the colour of solution turns to blue, continue titration till the colour disappears.

</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td></td></tr>
<tr><td>8</td><td>Observation Table</td><td>
<table>
<tr><th>Trial no</th><th>Volume of sample</th><th colspan="3">Burette reading</th><th>Sodium thiosulphate rundown</th></tr>
<tr><td></td><td></td><th>Initial reading</th><th>Final reading</th><th>Avg</th><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>9</td><td>Sample Calculations</td><td>Dissolved oxygen (mg/l) = ((A-B)×normality of sodium Thiosulphate×8000)/(ml of sample taken)
Dissolved oxygen (mg/l) for tap water=_____mg/l.
Dissolved oxygen (mg/lit) for given water sample=_____mg/l.</td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td>Dissolved oxygen present in the given tap water sample=_____mg/lit. Dissolved oxygen present in the given water sample=_____mg/lit.</td></tr>
<tr><td>12</td><td>Application Areas</td><td>Analysis of water</td></tr>
<tr><td>13</td><td>Remarks</td><td></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td></td></tr>
</table>

Experiment 04 : BIOCHEMICAL OXYGEN DEMAND

<table>
<tr><td>-</td><td>Experiment No.:</td><td>3</td><td>Marks</td><td></td><td>Date Planned</td><td></td><td>Date Conducted</td><td></td></tr>
<tr><td>1</td><td>Title</td><td colspan="7">Biochemical Oxygen Demand</td></tr>
<tr><td>2</td><td>Course Outcomes</td><td colspan="7">Students are able to determine Dissolved oxygen in a given sample</td></tr>
<tr><td>3</td><td>Aim</td><td colspan="7">To determine the biochemical oxygen demand in the given sample of water.</td></tr>
<tr><td>4</td><td>Material / Equipment Required</td><td colspan="7">

Lab Manual
BOD bottle 300 capacity.
Incubator, to be controlled at $2^0C \pm 1^0C$.
Burette,
Pipette and
Measuring jar

</td></tr>
<tr><td>5</td><td>Theory, Formula,</td><td colspan="7">BOD is defined as the amount of oxygen required by micro organisms while</td></tr>
</table>

<table>
<tr><td></td><td>Principle, Concept</td><td>stabilizing biologically decomposable organic matter in a waste under aerobic conditions. The BOD test is widely used to determine
The pollution load of waste water,
The degree of pollution in lakes and streams at any time and their self purification capacity and
Efficiency of waste water treatment methods.
Since the test is mainly a bio-assay procedure, involving measurement of oxygen consumed by bacteria while stabilizing organic matter under aerobic conditions, it is necessary to provide standard conditions of nutrient supply, ph, absence of microbial growth inhibiting substances and temperature. Because of the low solubility of o2 in water, strong wastes are always diluted to ensure that the demand does not increase the available O_2. A mixed group of organisms should</td></tr>
<tr><td>6</td><td>Procedure, Program, Activity, Algorithm, Pseudo Code</td><td>• Aerate the required volume of distilled water in a container by bubbling compressed air for about 15 min to attain DO saturation. Try to maintain the temperature near 20^0C.
• Add 1ml of phosphate buffer, magnesium sulphate, calcium chloride and ferric chloride solution for each litter of dilution water. Mix well.
• In the case of the wastes which are not expected to have sufficient bacterial pollution, add seed to the dilution water. Generally, 2ml settled sewage is considered sufficient for 100ml of dilution water.
<u>DILUTION OF SAMPLE</u>
• Neutralize the sample to pH around 7.0 if it is highly alkaline or acidic.
• The sample should be free from residual chlorine. If it contains residual chlorine remove it by using sodium Thiosulphate solution as follows
• Take 50ml of the sample and acidify with addition of 10ml 1+1 acetic acid. Add about 1kg KI. Titrate with sodium thiosulphate 0.025N using starch indicator. Calculate the volume of sodium thiosulphate required per ml of the sample and add accordingly to the sample to be tested for BOD.
• Samples having high DO content i.e. DO 9mg/l, due to either algal growth or some other reason, reduce the DO content by aerating the samples.
• Make several dilutions of the pretreated sample so as to obtain about 50% depletion of DO in dilution water but not less than 2mg and the residual O_2 after 5 days of incubation should not be less than 1mg/lit. prepare dilutions as follows
• Siphon out seeded dilution water in a measuring cylinder or volumetric flask half the required volume. Add the required quantity of carefully mixed sample. Dilute to the desired volume by siphoning dilution water and mix well.
DO (10%) =_____ml

DO (AV %) =_____ml</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td></td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td>
<table>
<tr><td>Sample</td><td colspan="2">Burette reading</td><td>Volume(ml)</td></tr>
<tr><td></td><td>Final reading</td><td>Initial reading</td><td></td></tr>
</table>
</td></tr>
</table>

		Blank			
		10% dilution			
		20% dilution			
9	Sample Calculations	C_5=_____ml D_5 (10%) =_____ml D_5 (AV %) =_____ml BOD mg/l= ((D_5-D_0)-(C_5-C_0))/ (ml of sample used in decimals) Where: D_5 and D_0 = DO in sample after 5 days and initial day respectively C_5 and C_0=DO in blank after 5 days and initial day respectively			
10	Graphs, Outputs				
11	Results & Analysis				
12	Application Areas	Water quality analysis			
13	Remarks				
14	Faculty Signature with Date				

Experiment 05 :DETERMINATION OF CHLORIDE BY ARGENTOMETRIC METHOD OR MOHR'S SALT METHOD

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Chlorides by Argentometric methods						
2	Course Outcomes	Students are able to determine chlorides in a given sample						
3	Aim	To determine the chloride contents in the given sample of water						
4	Material / Equipment Required	• Lab Manual • Burette, • conical flask and measuring jar.						
5	Theory, Formula, Principle, Concept	Chloride ion is determined by Mohr's method, titration with standard silver nitrate solution in which silver chloride is pipette first. The end point of titration is indicated by the formation of red silver chromate from excess $AgNO_3$ and potassium chromate used as indicator in neutral to slightly alkaline solution.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	• Take 100ml of the sample in the conical flask. • Add 2 to 3 drops of potassium chromate indicator into the solution and shake well. The solution turns to pale yellow. • Titrate it against standard silver nitrate solution (0.0141N). • Continue the titration till the end point of pale yellow to brick red is reached. • Note down the reading (i.e. volume of silver nitrate added-A) • Continue the same procedure for 100ml distilled water and note down the volume of silver nitrate-(B).						
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	Burette: $AgNO_3$ – 0.0141N Conical flask: water sample Indicator: K_2CrO_4 (potassium chromate, yellow) End point: reaction completion point colour changes from yellow to brick red.						

Sample	**Trial no**	**Vol of**	**Observation**	**$AgNO_3$**	**Chloride**

		details		**sample taken (ml)**		**solution used**	**(mg/l)**
				Initial reading	Final reading		
8	Observation Table, Look-up Table, Output						
9	Sample Calculations	Cl (mg/l) = ((A-B)×(normality of $AgNO_3$×35.45×1000))/ (ml of sample) (mg/l) = ((A-B)×(normality of $AgNO_3$×35.45×1000))/ (ml of sample) Cl (mg/l) = ((A-B)×(normality of $AgNO_3$×35.45×1000))/ (ml of sample) Sample 01= Sample 02= Sample 03=					
10	Graphs, Outputs						
11	Results & Analysis	Chloride content in given water Sample 01:_____mg/l. Sample 02:_____mg/l. Sample 03:_____mg/l.					
12	Application Areas						
13	Remarks						
14	Faculty Signature with Date						

Experiment 06 : AVAILABLE CHLORINE IN BLEACHING POWDER

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Available chlorine in bleaching powder						
2	Course Outcomes	Students are able to determine Available chlorine in a given sample						
3	Aim	To determine the Available chlorin in the given sample of water						
4	Material / Equipment Required	• Conical flask, Burette, • Pipette and Volumetric flask • Bleaching powder, • Glacial acetic acid, • Potassium iodide crystals or powder, • Standard sodium thiosulphate (0.1N), • Starch indicator solution						
5	Theory, Formula, Principle, Concept	Bleaching powder is nothing but chlorinated rinse or $CaOCl_2$ (calcium oxychloride). This compound is a white amorphous powder with a pungent smell of. When freshly made, it contains about 30-35% of available chlorine. It is however an unstable compound and on exposure to air, light and moisture it rapidly lose its chlorine content. Bleaching powder is used for treating small water surplus swimming pools and it can also be used as emergency disinfectant.						

<table>
<tr><td>6</td><td>Procedure, Program, Activity, Algorithm, Pseudo Code</td><td colspan="6">• Measure exactly 5gm of given bleaching powder and dissolve it completely in 1000 ml of distilled water.
• Take 100ml of solution and add 1g of KI crystals and about 5ml of glacial acetic acid. Leave the sample for 10 min for reaction.
• Titrate the solution against standard sodium thiosulphate of 0.1N until the colour turns to pale yellow.
• Add 2 to 3 drops of starch indicator solution and continue the titration till the solution turns blue to colourless. Note down the burette reading (A).
• Repeat the titration for distilled water (B).</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td colspan="6"><table>
<tr><th rowspan="2">Sl No</th><th rowspan="2">Sample</th><th colspan="2">Burette reading</th><th rowspan="2">ml of sodium thiosulphate used</th><th rowspan="2">Available Chlorine</th></tr>
<tr><th>Initial reading</th><th>Final reading</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td colspan="6"></td></tr>
<tr><td>9</td><td>Sample Calculations</td><td colspan="6">Available chlorine in bleaching powder = ((A-B)×0.1×35.45×1000)/ (volume of sample)
Available chlorine in bleaching powder = ((A-B)×0.1×35.45×1000)/ (volume of sample)
=_____mg/l.
% of chlorine = ((available chlorine)/1000)×100
=_____%</td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td colspan="6"></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td colspan="6"></td></tr>
<tr><td>12</td><td>Application Areas</td><td colspan="6">Analysis of chemical characteristics of water</td></tr>
<tr><td>13</td><td>Remarks</td><td colspan="6"></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td colspan="6"></td></tr>
</table>

Experiment 07 : RESIDUAL CHLORINE

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Residual chlorine in bleaching powder						
2	Course Outcomes	Students are able to determine Residual chlorine in a given sample						
3	Aim	To determine the Available chlorine in the given sample of water						
4	Material / Equipment Required	• Conical flask, Burette, • Pipette and Volumetric flask • Bleaching powder,						

<table>
<tr><td></td><td></td><td>

Glacial acetic acid,
Potassium iodide crystals or powder,
Standard sodium thiosulphate (0.1N),
Starch indicator solution

</td></tr>
<tr><td>5</td><td>Theory, Formula, Principle, Concept</td><td><u>DOSAGE OF CHLORINE:</u> The amount of chlorine required for the water depends upon the amount of inorganic impurities and organic impurities present in it when chlorine is added to water it first reacts with inorganic impurities like Sr^{-}, Mn^{2+}, NO^{2-}, Fe^{2+}, etc which converts the chlorine into chloride. After this point excess chlorine is consumed by ammonia to form chloramines. After this point chlorine will react with organic impurities present in water. The chlorine used in all the above reaction represents chlorine demand of water once after chlorine demand is satisfied the chlorine will appear to be free chlorine (residual chlorine). The function of free residual chlorine is to immediately kill the pathogens where as Cl will provide long term germicide effect</td></tr>
<tr><td>6</td><td>Procedure, Program, Activity, Algorithm, Pseudo Code</td><td>

Take 100ml of sample in a conical flask and add a pinch of potassium iodide.
Add 5ml of acetic acid and allow the reaction to complete.
Titrate the sample against 0.0025N of sodium thiosulphate solution until the yellow colour disappears
Add 1ml of starch solution, blue colour appears then continue the titration until the blue colour disappears (A-B).

</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td>
<table>
<tr><td rowspan="2">Sl No</td><td rowspan="2">Sample</td><td colspan="2">Burette reading</td><td rowspan="2">ml of sodium thiosulphate used</td><td rowspan="2">Residual Chlorine</td></tr>
<tr><td>Initial reading</td><td>Final reading</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td></td></tr>
<tr><td>9</td><td>Sample Calculations</td><td>Residual chlorine = ((A-B)×0.0025×35.45×1000)/(volume of sample).
Residual chlorine = ((A-B)×0.0025×35.45×1000)/ (volume of sample).
=_____mg/l</td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td>Residual chlorine = ((A-B)×0.0025×35.45×1000)/ (volume of sample).
=_____mg/l.</td></tr>
<tr><td>12</td><td>Application Areas</td><td>Analysis of chemical characteristics of water</td></tr>
<tr><td>13</td><td>Remarks</td><td></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td></td></tr>
</table>

Experiment 08 : *DETERMINATION OF SOLIDS IN SEWAGE:*

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	**Total soilds**						
2	Course Outcomes	Students are able to determine total solids in a given sample						
3	Aim	To determine the total solids in the given sample of water						
4	Material / Equipment Required	Evaporating dish, oven and desiccators.						
5	Theory, Formula, Principle, Concept	Total solids are determined as a residue left after evaporation and drying of the un-filtered sample.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	• Take 100ml of well mixed sample and pour it into evaporating dishes which is already been heated in an oven at 103^0C for removing the moisture and desiccated for balancing the temperature and weighed (W_1). • Heat the sample until it is dried (24hrs). • Take out the evaporating dish ported in a desiccators and take out the final reading (W_2).						
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							
8	Observation Table, Look-up Table, Output	Weight of the empty dish, W_1=_____g. Weight of the sample with dish (oven dried), W_2=_____g. Volume of the sample taken, V=_____ g						
9	Sample Calculation	Initial weight of the evaporating dish (W_1) =_____g Final weight of the evaporating dish (W_2) =_____g. Total solids = ((W_2-W_1)×1000×1000)/ (volume of sample). =_____mg/l.						
10	Graphs, Outputs							
11	Results & Analysis	Total solids of a given sample =_____mg/l.						
12	Application Areas	Analysis of chemical characteristics of water						
13	Remarks							
14	Faculty Signature with Date							

Experiment 09 : Total suspended solids

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	**Total suspended solids**						
2	Course Outcomes	Students are able to determine total solids in a given sample						
3	Aim	To determine the total solids in the given sample of water						
4	Material / Equipment Required	Evaporating dish, oven and desiccators.						
5	Theory, Formula, Principle, Concept	A well mixed sample is filtered through a filter paper and the residue retained on the filter is dried to a constant weight 103ºc. The increase in weight of filter paper represents the total suspended solids .						
6	Procedure,	• Take a wattman filter paper.						

	Program, Activity, Algorithm, Pseudo Code	• Place in an oven and heat it at 103^0C to remove the moisture. Take a filter paper from the oven placed in desiccators to balance the temperature and take the initial weight (W_1). • Pour known volume of well mixed sample to the filter paper. • Once after the completion of filtration take the filter paper place it in an the oven and heat it for 103^0 C for 1 hour. • Take out the filter paper from oven and place it in the desiccators to balance the temperature and note down the final reading (W_2).
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	Empty weight of filter paper, W_1=_____g. Weight of filter paper + suspended solids, W_2=_____g. Volume of sample=_____ml. Total suspended solids = ((W_2-W_1)*1000*1000)/ (volume of sample). =_____mg/l.
9	Sample Calculation	
10	Graphs, Outputs	
11	Results & Analysis	suspended solids of a given sample =_____mg/l.
12	Application Areas	Analysis of chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

Experiment 10 : TOTAL DISSOLVED SOLIDS

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Total Dissolved solids						
2	Course Outcomes	Students are able to determine total dissolved solids in a given sample						
3	Aim	To determine the total dissolved solids in the given sample of water						
4	Material / Equipment Required	Evaporating dish, oven and desiccators.						
5	Theory, Formula, Principle, Concept	A well mixed sample is filtered through a filter paper and the residue retained on the filter is dried to a constant weight 103ºc. The increase in weight of filter paper represents the total suspended solids .						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	•Take an evaporating dish, heat it in the oven to remove the moisture, place it in a dissector to balance the temperature and take the initial weight W_1. Take known volume of well mixed sample and filter it from a filter paper which is previously dried and weighed evaporating dish. The filtrate left over in an evaporating dish is dried at 103^0C and desiccated for balancing the temperature and weight take the final						

		weight W_2.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	Empty weight of evaporating dish, W_1=_____g. Weight of sample with dish after filtration (after oven drying), W_2 =_____g Volume of sample=_____ml Total dissolved solids = ((W_2-W_1)×1000×1000)/ (volume of sample). =_____mg/l.
9	Sample Calculation	
10	Graphs, Outputs	
11	Results & Analysis	Total dissolved solids =_____mg/l.
12	Application Areas	Analysis of chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

Experiment 11 : TOTAL FIXED AND VOLATILE SOLIDS

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Total fixed and Volatile solids						
2	Course Outcomes	Students are able to determine total solids in a given sample						
3	Aim	To determine the total fixed solids in the given sample of water						
4	Material / Equipment Required	1. Evaporating dish. 2. Oven 103^{0}C 3. Muffle furnace 600^{0}C 4. Desiccators 6. Water Bath						
5	Theory, Formula, Principle, Concept	Total volatile solids and fixed solids are determined as residue remaining after evaporation, drying at 103^0 C and ignition at 600^{0}C. .						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	• A clean porcelain dish is ignited in a muffle furnace and after partial cooling in air, it is cooled in a desiccators and weighed (W_1). • A 100 ml of well mixed sample (graduated cylinder in rinsed to ensure transfer of all suspended matter) is placed in the dish and evaporated at 100^{0}C on water bath, followed by drying in oven at 103^{0}C for 1 hour. • Dry to a constant weight at 103^{0}C, cool in desiccator and weighed (W_2). • Ignite the residue on evaporation at 600^{0}C in the muffle furnace to constant weight in 10 to 15 min. • Allow the dish to cool and moisten the ash with a few drops of distilled water. • Dry to constant weight at 104^{0}C, cool in a desiccators and weighed (W_3).						
7	Block, Circuit,							

	Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	

Type of solids	**Sample details**	**Volume of sample, ml**	**Weight of empty dish (mg)**	**Weight of empty dish+ Residue (mg)**	**Residue (mg/l)**

9	Sample Calculation	Total solids (mg/l) = $((W_2-W_1)\times1000\times1000)$/ (volume of sample). =_____mg/l. Total volatile solids (mg/l) = Total solids-Fixed solids. =_____mg/l. Total fixed solids (mg/l) = $((W_3-W_2)\times1000\times1000)$/ (volume of sample). =_____mg/l.
10	Graphs, Outputs	
11	Results & Analysis	The amount of Total, fixed and volatile solids of the given sample is=_____ mg/l
12	Application Areas	Analysis of chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

Experiment 11 : TOTAL SETTLEABLE SOLIDS

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Total Settleable solids						
2	Course Outcomes	Students are able to determine total Settleable solids in a given sample						
3	Aim	To determine the total Settleable solids in the given sample of water						
4	Material / Equipment Required	Imhoff cone. Holding device .						
5	Theory, Formula, Principle, Concept	The particles in suspensions whose specific gravity greater than that of water will settle under quiescent conditions						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	• Gently fill the Imhoff cone with the thoroughly well mixed sample usually one liter and allow it to settle. • After 45 minutes, gently rotate the cone between hands to ensure that all solids adhering to the sides are loosened. • Allow the solids to settle for 15 minutes more, to make up for a total period of 1 hour.						

		• Read the volume of the sludge which has settled in the apex. • Express the results in ml settleable solids per liter of sample per hour.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	**Sample details** | **Sample details** | **Total settleable solids ml/l/hour** | | | | | | | | |
9	Sample Calculation	Total settleable solids (mg/l)= (ml of solids x 1000)/ml of sample.
10	Graphs, Outputs	
11	Results & Analysis	Total settlable solids of the given sample is = _____ mg/l.
12	Application Areas	Analysis of chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

Experiment 12: TURBIDITY DETERMINATION BY NEPHELOMETER

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Turbidity of a given sample						
2	Course Outcomes	Students are able to determine to turbidity in a given sample						
3	Aim	To determine the total turbidity in the given sample of water						
4	Material / Equipment Required	• Nephelo-turbidity meter. • Beaker. • Pipette.						
5	Theory, Formula, Principle, Concep	When light is passed through a sample having suspended particles, some of the light is scattered by particles. This scattering of light is generally proportional to the turbidity. The turbidity sample is of thus measured from the amount of light scattered by the sample, taking a reference with standard turbidity suspension.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	• Switch on the instrument and allow it to warm up. • Take the standard suspension of the sample and calibrate the instrument. • After the calibration place the cattle with the sample and note down the turbidity directly from the instrument						
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							
8	Observation Table, Look-up Table, Output	Sl no. | **Sample details** | **Turbidity (NTU)** | | | | | | | | |						

9	Sample Calculation	
10	Graphs, Outputs	
11	Results & Analysis	The turbidity of the given sample is _____ NTU.
12	Application Areas	Analysis of chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

Exeriment 13:OPTIMUM DOSAGE COAGULANTS

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Jar test apparatus						
2	Course Outcomes	Students are able to determine optimum dosage of coagulants in a given sample						
3	Aim	To determine the optimum dosage of coagulants in the given sample of water						
4	Material / Equipment Required	• Jar test apparatus. • Beakers. • Turbidity meter • pH meter						
5	Theory, Formula, Principle, Concept	Metal salts hydrolyze in presence of the natural alkalinity to form metal hydroxides. The divalent cations can reduce the zeta- potential, while the metal hydroxides are good absorbents and hence remove the suspended particles by enmeshing them						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	• Measure the turbidity of given sample. • Take 1 litre of sample into each of 6 beakers. • Switch on the motor and adjust the speed of paddles to 100 rpm.4. Add varying doses of alum solution i.e., 1 ml, 2ml, 3ml, 4ml, 5ml, 6ml to different beakers simultaneously.(The doses vary with turbidity in water sample). • Allow flash mix for 1 minute. • Reduce the speed of paddles to 40 rpm and continue mixing for 10 minutes. • Switch off the motor and allow 20 minutes for settling of flocs. • Collect the supernatant without disturbing the sediment and find the turbidity of each beaker. • Repeat the experiment with high doses of alum if satisfactory results are not obtained						
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							
8	Observation Table, Look-up Table, Output							

SL NO.	Vol. of sample	Beaker No	Weight of alum added	Initial turbidity NTU	Final turbidity NTU	turbidity removed

9	Sample Calculation	Raw water turbidity (NTU) =_____ Raw water pH =_____ Raw water Alkalinity (mg/l) =_____
10	Graphs, Outputs	
11	Results & Analysis	Ideal dosage of coagulant (mg/l) = _____
12	Application Areas	Analysis of chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

Exeriment 14:DETERMINATION OF SODIUM BY FLAME PHOTOMETER

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Jar test apparatus						
2	Course Outcomes	Students are able to determine sodium content in a given sample						
3	Aim	To determine the amount of Sodium present in the given sample solution.						
4	Material / Equipment Required	• Flame photometer • Volumetric flasks • Pipette						
5	Theory, Formula, Principle, Concept	Flame emission spectroscopy is a type of atomic emission spectroscopy. It is mostly applicable for analysis of alkali and alkali earth metals. In this spectroscopy, the sample solution of sodium salt is nebulized in to flame, which may produce solid residue upon solvent evaporation. This solid residue undergoes atomization and gives neutral atoms which may acquire thermal energy from flame and undergoes electronic excitation. Due to unstable nature of excited state, excited atoms come back to ground state by emission of absorbed energy as visible radiation. By measuring the wavelength and intensity of emitted radiation, we can do qualitative and quantitative analysis respectively.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	**Preparation of standard solutions for calibration curve:** Dissolve exactly 1.88 gm of Sodium chloride in water and make up to 1 liter. This contains1mg per ml (1000 ppm). **Estimation of Sodium by flame photometer:** • First, switch on the digital flame photometer followed by the air compressor with the required value (10 bar). • Open the gas from the gas cylinder (after the instrument is warmed up for 10 minutes). Initially allow the ion-free water (distilled water) to aspirate in to the flame and set the digital value as 100. Now the instrument is said to be calibrated. After this calibration of the instrument, no adjustment should be made .Introduce the solutions containing different concentrations of Sodium chloride (2, 4, 6, 8, 10µg) to the flame and find out the intensity of emitted light of each solution. • Plot a calibration graph between concentration and intensity of NaCl solution which passes through the origin. Finally, introduce the sample of						

<table>
<tr><td></td><td></td><td></td><td>unknown solution containing sodium into the flame and find out the intensity of emitted radiation. From the intensity, the concentration of unknown solution can be determined</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td colspan="3"></td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td colspan="3"><table><tr><td>SL NO.</td><td>Concentration of NaCl Solution(ppm)</td><td>Flame intensity</td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>9</td><td>Sample Calculation</td><td colspan="3"></td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td colspan="3"></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td colspan="3">The amount of Sodium in the given sample……..ppm</td></tr>
<tr><td>12</td><td>Application Areas</td><td colspan="3">Analysis of chemical characteristics of water</td></tr>
<tr><td>13</td><td>Remarks</td><td colspan="3"></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td colspan="3"></td></tr>
</table>

Exeriment 15:DETERMINATION OF POTASSIUM BY FLAME PHOTOMETRY

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Jar test apparatus						
2	Course Outcomes	Students are able to determine potassium content in a given sample						
3	Aim	To determine the amount of potassium present in the given sample solution.						
4	Material / Equipment Required	• Flame photometer • Volumetric flasks • Pipette						
5	Theory, Formula, Principle, Concept	Flame emission spectroscopy is a type of atomic emission spectroscopy. It is mostly applicable for analysis of alkali and alkali earth metals. In this spectroscopy, the sample solution of sodium salt is nebulized in to flame, which may produce solid residue upon solvent evaporation. This solid residue undergoes atomization and gives neutral atoms which may acquire thermal energy from flame and undergoes electronic excitation. Due to unstable nature of excited state, excited atoms come back to ground state by emission of absorbed energy as visible radiation. By measuring the wavelength and intensity of emitted radiation, we can do qualitative and quantitative analysis respectively.						

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>6</td><td>Procedure, Program, Activity, Algorithm, Pseudo Code</td><td>Preparation of standard solutions for calibration curve:
Dissolve exactly 1.88 gm of Sodium chloride in water and make up to 1 liter. This contains1mg per ml (1000 ppm).

Estimation of Sodium by flame photometer:

• First, switch on the digital flame photometer followed by the air compressor with the required value (10 bar).
• Open the gas from the gas cylinder (after the instrument is warmed up for 10 minutes). Initially allow the ion-free water (distilled water) to aspirate in to the flame and set the digital value as 100. Now the instrument is said to be calibrated. After this calibration of the instrument, no adjustment should be made .Introduce the solutions containing different concentrations of Sodium chloride (2, 4, 6, 8, 10µg) to the flame and find out the intensity of emitted light of each solution.
• Plot a calibration graph between concentration and intensity of NaCl solution which passes through the origin. Finally, introduce the sample of unknown solution containing sodium into the flame and find out the intensity of emitted radiation. From the intensity, the concentration of unknown solution can be determined</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td></td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td><table><tr><td>SL NO.</td><td>Concentration of KCL Solution(ppm)</td><td>Flame intensity</td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>9</td><td>Sample Calculation</td><td></td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td>The amount of potasium in the given sample…….ppm</td></tr>
<tr><td>12</td><td>Application Areas</td><td>Analysis of chemical characteristics of water</td></tr>
<tr><td>13</td><td>Remarks</td><td></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td></td></tr>
</table>

Exeriment 16:DETERMINATION OF NITRATES BY SPECTROSCOPIC METHOD

<table>
<tr><td>-</td><td>Experiment No.:</td><td>1</td><td>Marks</td><td></td><td>Date Planned</td><td></td><td>Date Conducted</td><td></td></tr>
<tr><td>1</td><td>Title</td><td colspan="7">Jar test apparatus</td></tr>
<tr><td>2</td><td>Course Outcomes</td><td colspan="7">Students are able to determine nitrates content in a given sample</td></tr>
<tr><td>3</td><td>Aim</td><td colspan="7">To determine the amount of nitrates present in the given sample solution.</td></tr>
<tr><td>4</td><td>Material / Equipment Required</td><td colspan="7">• Flame photometer
• Volumetric flasks
• Pipette</td></tr>
<tr><td>5</td><td>Theory, Formula, Principle, Concept</td><td colspan="7">Flame emission spectroscopy is a type of atomic emission spectroscopy. It is mostly applicable for analysis of alkali and alkali earth metals. In this spectroscopy, the sample solution of sodium salt is nebulized in to flame, which may produce solid residue upon solvent evaporation. This solid residue undergoes atomization and gives neutral atoms which may acquire thermal energy from flame and undergoes electronic excitation. Due to unstable nature of excited state, excited atoms come back to ground state by emission of absorbed energy as visible radiation. By measuring the wavelength and intensity of emitted radiation, we can do qualitative and quantitative analysis respectively.</td></tr>
<tr><td>6</td><td>Procedure, Program, Activity, Algorithm, Pseudo Code</td><td colspan="7">Preparation of standard solutions for calibration curve:
Dissolve exactly 1.88 gm of Sodium chloride in water and make up to 1 liter. This contains1mg per ml (1000 ppm).

Estimation of Sodium by flame photometer:

• First, switch on the digital flame photometer followed by the air compressor with the required value (10 bar).
• Open the gas from the gas cylinder (after the instrument is warmed up for 10 minutes). Initially allow the ion-free water (distilled water) to aspirate in to the flame and set the digital value as 100. Now the instrument is said to be calibrated. After this calibration of the instrument, no adjustment should be made .Introduce the solutions containing different concentrations of Sodium chloride (2, 4, 6, 8, 10µg) to the flame and find out the intensity of emitted light of each solution.
• Plot a calibration graph between concentration and intensity of NaCl solution which passes through the origin. Finally, introduce the sample of unknown solution containing sodium into the flame and find out the intensity of emitted radiation. From the intensity, the concentration of unknown solution can be determined</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td colspan="7"></td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td colspan="7"><table><tr><td>SL NO.</td><td>Concentration of Agcl Solution(ppm)</td><td>Flame intensity</td></tr><tr><td></td><td></td><td></td></tr></table></td></tr>
</table>

9	Sample Calculation	
10	Graphs, Outputs	
11	Results & Analysis	Nitrate nitrogen (mg/l) =_____
12	Application Areas	Analysis of chemical characteristics of water
13	Remarks	
14	Faculty Signature with Date	

Exeriment 17:DETERMINATION OF IRON BY PHENANTHROLINE METHOD

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Jar test apparatus						
2	Course Outcomes	Students are able to determine iron content in a given sample						
3	Aim	To determine the amount of iron present in the given sample solution.						
4	Material / Equipment Required	• Flame photometer • Volumetric flasks • Pipette						
5	Theory, Formula, Principle, Concept	Flame emission spectroscopy is a type of atomic emission spectroscopy. It is mostly applicable for analysis of alkali and alkali earth metals. In this spectroscopy, the sample solution of sodium salt is nebulized in to flame, which may produce solid residue upon solvent evaporation. This solid residue undergoes atomization and gives neutral atoms which may acquire thermal energy from flame and undergoes electronic excitation. Due to unstable nature of excited state, excited atoms come back to ground state by emission of absorbed energy as visible radiation. By measuring the wavelength and intensity of emitted radiation, we can do qualitative and quantitative analysis respectively.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	**Preparation of standard solutions for calibration curve:** Dissolve exactly 1.88 gm of Sodium chloride in water and make up to 1 liter. This contains1mg per ml (1000 ppm). **Estimation of Sodium by flame photometer:** • First, switch on the digital flame photometer followed by the air compressor with the required value (10 bar). • Open the gas from the gas cylinder (after the instrument is warmed up for 10 minutes). Initially allow the ion-free water (distilled water) to aspirate in to the flame and set the digital value as 100. Now the instrument is said to						

<table>
<tr><td></td><td></td><td>be calibrated. After this calibration of the instrument, no adjustment should be made .Introduce the solutions containing different concentrations of Sodium chloride (2, 4, 6, 8, 10µg) to the flame and find out the intensity of emitted light of each solution.
• Plot a calibration graph between concentration and intensity of NaCl solution which passes through the origin. Finally, introduce the sample of unknown solution containing sodium into the flame and find out the intensity of emitted radiation. From the intensity, the concentration of unknown solution can be determined</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td></td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td><table><tr><td>SL NO.</td><td>Concentration of HCL Solution(ppm)</td><td>Flame intensity</td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>9</td><td>Sample Calculation</td><td></td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td>Iron content of the sample (mg/l) = _____</td></tr>
<tr><td>12</td><td>Application Areas</td><td>Analysis of chemical characteristics of water</td></tr>
<tr><td>13</td><td>Remarks</td><td></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td></td></tr>
</table>

F. Content to Experiment Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Expt-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	B	C	D	E	F	G	H
1	Determination of pH, Acidity and Alkalinity	3	- - L3 -	L3	-Analyse -	- Lecture - Demonstration -	CIA
2	Determination of Calcium, Magnesium and Total Hardness.	3	- - L3 -	L3	-Analyse	- Lecture - Demonstration -	CIA
3	Determination of Dissolved Oxygen. Determination of BOD	3	- - L3 -	L3	- -Analyse	- Lecture - Demonstration	CIA
4	Determination of Chlorides	3	- - L3 -	L3	- -Analyse	- Lecture - Demonstration	CIA
5	Determination of percentage of available chlorine in bleaching powder,	3	- - L3 -	L3	- -Analyse	- Lecture - Demonstration	CIA
6	Determination of Residual Chlorine	3	- - L3 -	L3	- -Analyse	- Lecture - Demonstration	CIA
7	Determination of Solids in Sewage: I) Total Solids, II) Suspended Solids, III) Dissolved Solids,Volatile Solids, Fixed Solids, V) Settle able Solids.	3	- - L3 -	L3	- -Analyse	- Lecture - Demonstration -	CIA
8	Determination of Turbidity by Nephelometer	3	- - L3 -	L3	-Analyse -	- Lecture - Demonstration -	CIA
9	Determination of Optimum Dosage of Alum using Jar test apparatus.	3	- - L3 -	L3	- -Analyse	- Lecture - Demonstration -	CIA

10	Determination of sodium and potassium using flame photometer.	3	L3	L3	Analyse	Lecture Demonstration	CIA
11	Determination Nitrates by spectrophotometer.	3	L3	L3	Analyse	Lecture Demonstration	CIA
12	Determination of Iron & Manganese	3	L3	L3	Analyse	Lecture Demonstration	CIA
13	Determination of COD	3	L2	L2		Lecture Demonstration	CIA
14	Air Quality Monitoring (Ambient, stack monitoring , Indoor air	3	L2	L2		Lecture Demonstration	CIA
15	Determination of Sound by Sound level meter at different location	3	L2	L2		Lecture Demonstration	CIA

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Expt - #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	-understand the importance of water quality standards -	-Quality standards -	Quality standards	understand the importance of water quality standards	-Analyse	The students will be able to understand the importance of water quality standards
2	-analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity -	-pH, Acidity and Alkalinity -	pH, Acidity and Alkalinity	analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity -	-Analyse	The student will be able to analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity
3	-analyse the physical characteristics viz. colour, turbidity, and Hardness of a given water sample -	-Calcium, Magnesium and Total Hardness. -	Calcium, Magnesium and Total Hardness.	analyse the physical characteristics viz. colour, turbidity, and Hardness of a given water sample	-Analyse	The student will be able to analyse the physical characteristics viz. colour, turbidity, and Hardness of a given water sample
4	-analyse the Dissolved	- Dissolved	Dissolved Oxygen. BOD	-analyse the Dissolved oxygen	-Analyse	The student will be able to analyse the

	oxygen and biochemical oxygen demand in water and waste water -	Oxygen. BOD -		and biochemical oxygen demand in water and waste water -		Dissolved oxygen and biochemical oxygen demand in water and waste water
5	-determine the chlorides in the given sample -	- Chlorides -	Chlorides	determine the chlorides in the given	-Analyse	The student will be able to determine the chlorides in the given sample
6	-analyse the chemical characteristics of a given water sample viz. chlorides, Available Chlorine, residual chlorine content and turbidity to assess its suitability for drinking purposes -	-available chlorine, Residual Chlorine -	available chlorine, Residual Chlorine	analyse the chemical characteristics of a given water sample viz. chlorides, Available Chlorine, residual chlorine content and turbidity to assess its suitability for drinking purposes	-Analyse	To analyse the chemical characteristics of a given water sample viz. chlorides, Available Chlorine, residual chlorine content and turbidity to assess its suitability for drinking purposes
7	-determine the optimum dosage of alum using Jar test -	-Turbidity, -Optimum Dosage of Alum	Turbidity, Optimum Dosage of Alum	determine the optimum dosage of alum using Jar test	-Analyse	The student will be able to determine the optimum dosage of alum using Jar test
8	-analyse the chemical characteristics of a given water sample viz. Sodium and pottasium, Iron, nitrates, manganese content to assess its suitability for drinking purposes -	-sodium and potassium,Iron, manganese -	sodium and potassium,Iron, manganese	analyse the chemical characteristics of a given water sample viz. Sodium and pottasium, Iron, nitrates, manganese content to assess its suitability for drinking purposes	-Analyse	To analyse the chemical characteristics of a given water sample viz. Sodium and pottasium, Iron, nitrates, manganese content to assess its suitability for drinking purposes
9	-understand the Chemical Oxygen Demand in waste water -	-COD -	COD	understand the Chemical Oxygen Demand in waste water -	-Analyse	The student will be able to understand the Chemical Oxygen Demand in waste water

10	understand the Air quality Monitoring and sound level	Air quality, sound	Air quality, sound	understand the Air quality Monitoring and sound level	-Analyse	The student will be able to understand the Air quality Monitoring and sound level