Roll No. | | | | | | | | | | | | |

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20
Course Code: CIV 316
Course Name: INDUSTRIAL WASTEWATER TREATMENT
Program & Sem: B.Tech (Civil) & VII DE

Date: 27.09.2019
Time: 9:30 AM to 10:30AM
Max Marks: 40
Weightage: 20%

Instructions:

(i) ***Answer all the questions***
(ii) ***Use of Non-programmable calculators is permitted***
(iii) ***Assume suitable data, if necessary, by stating it clearly***

Part A (Memory Recall Questions)

Answer all the Questions. Each Question carries four marks. (3Qx4M=12M)

1. Differentiate between Municipal and Industrial wastewater? (C.O.NO.1) [Knowledge]

2. What are the advantages of COD over BOD? (C.O.NO.1) [Knowledge]

3. Determine ultimate BOD for a wastewater having 3 day BOD at 20 C as 120 mg/L. Assume reaction rate constant as 0.2 per day (C.O.NO.1) [Knowledge]

Part B (Thought Provoking Quesitons)

Answer all the Questions. Each Question carries six marks. (3Qx6M=18M)

4. Enlist the general standards for discharge of any eight environmental Pollutants of industrial effluents to be discharged into inland surface, public sewer and on land for irrigation, as per the Schedule-VI of The Environment (Protection) Rules, 1986. (C.O.NO.1) [Comprehension]

5. Describe the detailed investigation study to be carried out for ascertaining the pollution status of the natural lake near your locality considering the possible waste discharges into it.

(C.O.NO.1) [Comprehension]

6. What are the materials discharged in the industrial effluent cause water pollution

(C.O.NO.1) [Comprehension]

Part C (Problem Solving Questions)

Answer the Question. The Question carries ten marks. **(1Qx10M=10M)**

7. A wastewater treatment plant disposes of its effluent in a surface stream. Characteristics of the stream and effluent are shown below.

Parameter	Wastewater	Stream
flow (m^3/s)	0.2	5
Dissolved oxygen, mg/L	1	8
Temperature, °C	15	20.2
BOD_5 at 20°C, mg/L	100	2
Oxygen consumption rate (K1 at 20°C) (1/day)	0.2	-
Oxygen reaeration rate (K2 at 20°C) (1/day)	-	0.3

(a) What will be the dissolved oxygen conc. in the stream after 2 days?

(b) What will be the lowest dissolved oxygen concentration as a result of the waste discharge?

(c) Also calculate the maximum BOD5 (20°C) that can be discharged if a minimum of 4.0 mg/L of oxygen must be maintained in the stream?

(C.O.NO.1) [Application]

SCHOOL OF ENGINEERING

TEST – 1

Semester: VII
Course Code: CIV316
Course Name: Industrial Wastewater Treatment
Program & Sem: B.Tech Civil VII

Date: 27/09/2019
Time: 9:30 am to 10.30am
Max Marks: 40
Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels 12			Thought provoking type [Marks allotted] Bloom's Levels ~~12~~ 24			Problem Solving type [Marks allotted] 14			Total Marks
			K			C			A			
1	1	1 Basics of Industrial Wastewater	4									4
2	1	1 Basics of Industrial Wastewater		4								
3	1	1 Basics of Industrial Wastewater			4							
4	1	1 Basics of Industrial Wastewater				8						
5	1	1 Basics of Industrial Wastewater					8					

6		1 Basics of Industrial Wastewater						8				
7		1 Basics of Industrial Wastewater								14		14
	Total Marks			12			24				14	

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Dr. Jagdeesh H Godihal]

Reviewers' Comments

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

TEST – 1

Semester: VII

Course Code: CIV316

Course Name: Industrial Wastewater Treatment

Program & Sem: B.Tech Civil VII

Date: 27/09/2019

Time: 9:30 am to 10:30am

Max Marks 40

Weightage 20%

Part A (3Q x4 M = 12Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	• Domestic: wastewater by residential, shop houses, offices, schools etc. and normally generated from toilets, sinks and bathrooms. • Industrial: wastewater generated by industries Quantity and quality depends on the type of industry	2 2	3 minutes
2	advantages of COD over BOD (or limitations of BOD)- A high quantity of seed bacteria is required in BOD test if BOD concentration is of low order unlike COD test. Pretreatment is needed when dealing with toxic wastes as well as effect of nitrifying bacteria (if present in significant number) should be suppressed since carbonaceous BOD (not nitrogenous BOD) is the parameter to be measured. This is not the case with COD but sometimes dichromate	1	

	reacts with inorganic material augmenting the COD value. Only the biodegradable organics is measured in BOD test (BOD5 should be approximately equal to soluble and biodegradable COD) unlike COD test which measures complete organic material content. The relatively long period of time requires to measure BOD unlike COD (only 2.5 Hrs or rapid COD test takes 15 mins). Hence COD is preferred over BOD but still BOD test is checked for operating waste water treatment plants because- It checks whether the waste can be biologically treated/stabilized or not by evaluating BOD/COD ratio.	1 1 1	
3	Lo = Lt / (1 – e-kt) = 160 / (1 – e-0.20 x 5) = 232 mg/L	2 2	

Part B (3Q x8 M = 24 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
4	Inland surface water Public Sewers Land for irrigation Suspended solids mg/l, Max 100 600 200 pH Value 5.5 to 9.0 5.5 to 9.0 5.5 to 9.0 Oil and grease mg/l Max. 10 20 10 Total residual chlorin mg/l Max. 1.0 -- -- Ammonical nitrogen (as N), mg/l Max. 50 50 -- Total Kjeldahl Nitrogen (as NH3) mg/l. Max 100 - Free ammonia (as NH3) mg/l, Max. 5.0 -- -- Biochemical Oxygen demand 1 [3 days at 27 oC] mg/l max. 30 350 100 Chemical Oxygen Demand, mg/l, max. 250 -- -- 250 Arsenic (as As), mg/l, max. 0.2 0.2 0.2 Mercury (as Hg), mg/l. Max.. 0.01 0.01 -	1 each 1 x 8 = 8 M	
5	Identify the lake, Name, location, Area, Status of pollution, Number of sewage outlets, Industrial effluent discharges, SW dumped, Encroachment o lake, human settlements at the bank. Any attempt to rejunivate a lake has been done, Public	1 x 8 = 8 M	

	opinion, BBMP suggested solutions, executed, pipeline, what are your observations, recommendations, suggestions, Remedial measures etc		
6	Inorganic salts: Inorganic salts. which are present in most industrial wastes as well as in nature itself. cause water to be "hard" and make a stream undesirable for industrial, municipal and agricultural usage. Another disadvantage is that, under proper environmental conditions, inorganic salts especially nitrogen and phosphorous induce the growth of microscopic plant life (algae) in surface waters Acids and /or Alkalis: Acids and Alkalis discharged by chemical and other industrial plants make a stream undesirable not only recreational uses such as swimming and boating, but also for propagation of fish and other aquatic life. High concentrations of sulfuric acid, sufficient to lower the pH below 7.0 when free chlorine is present, have been reported to cause eye Organic matter: Organic Matter exhausts the oxygen resources of rivers and creates unpleasant tastes. odours and general septic conditions. It is generally conceded that the critical range for fish survival is 3to 4 mg/l of D.O certain organic chemicals such as phenols, affect the taste of domestic water supplies. Suspended solids. Floating Solids and liquids, heated water. Colour. Microorganisms. Radioactive materials. Foam producing materials. Toxic chemicals	1 x 8 = 8 M	

Part C

(1Q x 14M = 14Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
7	(see table below)	2	

Parameter	wastewater (given)	stream (given)	Wastewater and stream water mixture
flow (m^3/s)	0.2	5	$=Q_{mixture}=5+0.2=5.2$ m/s
Dissolved oxygen, mg/L	1	8	$DO_{mixture}=(0.2*1+8*5)/(5+0.2)$ =7.73 mg/L
Temperature, °C	15	20.2	$Temp_{mixture}=(0.2*15+20.2*5)/(5+0.2)$ =20 deg C (No temp. correction required)
BOD_5 at 20°C, mg/L	100	2	$BOD_{mixture}=(0.2*100+2*5)/(5+0.2)$ =5.77 mg/L
Oxygen consumption	0.2		0.23 (No temp. correction required) (assumed for stream water)

rate (K1 at °C) (1/day)			
Oxygen reaeration rate (K2 at °C) (1/day)	-	0.3	0.3 (No temp correction required)

Ultimate BOD= $Y_{ultimate}$=L_0 = (5-day BOD in mixture water)/[1-exp(-$K1_{mixture}$*5)]
=(5.77 mg/L)/ [1-exp(-0.23*5)] =8.44 mg/L

Initial DO deficit (D_0)
For 20°C stream water temperature, equilibrium concentration of oxygen =9.17 mg/L D_0 = 9.17 mg/L-7.73 mg/L = 1.44 mg/L

To get DO after 2 days in stream water after mixing, we need to calculate DO deficit after 2 days first and then calculate DO (at 2days). DO deficit at 2 days is given by
D (t=2 days) = [K1*L_0]*[exp (-K1*t)-exp (-K2*t)]/ (K2-K1) + D_0 exp (-K2*t)
= [0.2*8.44]*[exp (-0.2*2)-exp (-0.3*2)]/ (0.3-0.2) + 1.44 exp (-0.3*2)
= [1.94]*[0.6703-0.5488]/ (0.07) + 0.7903 =3.07 mg/L

D (t=2 days) = DO $_{saturated}$-DO (2day) = 3.07 mg/L 2
DO (2day) = 9.17-3.07=**6.10 mg/L (answer for part i)**

Time for critical DO deficit (t_c)= 1/ (K2-K1)*ln [(K2/K1)*(1-D_0 *(K2-K1)/ (K1L_0))]
= 1/ (0.3-0.23)*ln [(0.3/0.23)*(1-1.44 *(0.3-0.23)/ (0.23*8.44))]
= 14.29*ln [1.3*(1-1.44 *0.036)] = 14.29*ln [1.23] =2.95 days 2
Critical DO deficit (D_c)= (K1/K2)*L_0 exp (-K1*t_c)
= (0.23/0.3)*8.44 exp (-0.23*2.95) = 6.47 *0.507 =3.28 mg/L

D_c = $DO_{saturated}$-$DO_{critical}$ = 3.28 mg/L

$DO_{critical}$= 9.17-3.28=**5.89 mg/L (answer for part ii)**

Required minimum DO = 4.0 mg/L in stream water. As DO at critical location is 5.89 mg/L, greater than the recommended DO level no modification in wastewater effluent characteristics is required 2

To calculate maximum BOD_5 in effluent water, calculate allowable DO deficit (i.e., $D_{allowable}$)
= $DO_{saturated}$-$DO_{minimum}$ = 9.17-4.0 = 5.17 mg/L [Note that 5.17 mg/L DO deficit is allowable and we are having 5.89 mg/L critical DO deficit.]

Now with calculated allowable DO deficit (this is assumed to be the critical deficit now) and calculated $t_{critical}$ (assumed to be similar to previous case, i.e., 2.95 days), calculate ultimate BOD in this case. Then calculate 5-day BOD of the mixture stream water and then calculate 5-day BOD of the effluent which will be the desired maximum 5-day BOD value 2
$D_{allowable}$ (t=$t_{critical}$) =$D_{critical,new}$

=> 5.17 = (0.23/0.30)*L_0 [exp (-0.23*2.95)] = 0.77*0.51L_0=0.3927L_0
=> Ultimate BOD of the mixture water = L_0=5.19 mg/L / (0.3927) =13.17 mg/L
Now 5-day BOD in mixture water is calculated 5-day $BOD_{mixture}$ = L_0 *[1-exp (-$K1_{mixture}$*5)]
= (13.17 mg/L)*[1-exp (-0.23*5)] =9.0 mg/L 2

5-day BOD in effluent water is calculated now.

$BOD_{mixture}$= (5-day $BOD_{eff}Q_{eff}$+5-day $BOD_{stream}Q_{stream}$)/ (5+0 2) 9.0 mg/L = (5-day BOD_{eff}*0.2+2*5)/ (5+0 2)

5-day BOD_{eff} *0 2+10= 9.0*5.2 = 46.8

=> 5-day BOD_{eff} = (46.8-10)/0.2= 184 mg/L (answer for part iii). **This is maximum value of 5-day BOD in wastewater effluent which can be discharged in the stream water without exceeding the minimum required DO value of 4 mg/L.** 2

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PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20
Course Code: CIV 316
Course Name: INDUSTRIAL WASTEWATER TREATMENT
Program & Sem: B.Tech (Civil) & VII (DE)

Date: 16.11.2019
Time: 9:30 AM TO 10:30 AM
Max Marks: 40
Weightage: 20%

Instructions:

(i) Answer all the questions
(ii) Use of Non-programmable calculators is permitted
(iii) Assume suitable data, if necessary, by stating it clearly

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Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries two marks. **(4Qx2M=8M)**

1. Enlist the four benefits of equalization of industrial wastewater?
(C.O.NO.2)[Knowledge]
2. What do you mean by Pulping and state three requirement of a good raw material for Pulp and paper production.
(C.O.NO.2)[Knowledge]
3. Name three bye-products of sugar industry and identify the corresponding industry for which these bye products are used as a raw material.
(C.O.NO.2)[Knowledge]
4. What are the purposes of proportioning of industrial wastewater?
(C.O.NO.2)[Knowledge]

Part B[Thought Provoking Questions]

Answer both the Questions. Each Question carries six marks. **(2Qx6M=12)**

5. In general, the first step in minimizing the effects of industrial wastes on receiving streams and treatment plants is to reduce the volume of such wastes. Explain, citing examples various waste volume reduction methods practiced in industrial wastewater treatment processes.
(C.O.NO.2) [Comprehension]

6. The capital investment and running, operation and maintenance (ROM) costs can be achieved usually by reducing the amounts of contaminants entering the waste stream. Enlist three methods for strength reduction of industrial wastewater, citing examples for each method (C.O.NO.2) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries ten marks. (2Qx10M=20M)

7. With neat flow diagram describe the Kraft process of integrated pulp and paper mill, indicating the wastewater generation points. (C.O.NO.2) [Application]

8. Why the wastewater from sugar industry requires treatment? Explain the processes of treatment with block diagram of effluent treatment plant (ETP). (C.O.NO.2) [Application]

SCHOOL OF ENGINEERING

TEST – 2

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: VII

Course Code: CIV316

Course Name: Industrial Wastewater Treatment

Program & Sem: B.Tech Civil VII

Date: 16/11/2019

Time: 9:30 am to 10:30am

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K 8			C 12			A 20			
1	1	2 Characterization of Industrial Wastewater	2									2
2	1	2 Characterization of Industrial Wastewater		2								2
3		2 Characterization of Industrial Wastewater			2							2
4		2 Characterization of Industrial Wastewater			2							2
5		2 Characterization of Industrial Wastewater				6						6
6		2 Characterization of Industrial Wastewater					6					6
7		2 Characterization of Industrial Wastewater							10			10
8		2 Characterization of Industrial Wastewater								10		10
	Total Marks			8			12			20		

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

TEST – 2

Semester: VII

Course Code: CIV316

Course Name: Industrial Wastewater Treatment

Program & Sem: B.Tech Civil VII

Date: 16/11/2019

Time: 9:30 am to 10:30am

Max Marks: 40

Weightage: 20%

Part A (4Q x2 M = 8Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Equalization improves sedimentation efficiency by improving hydraulic retention time The efficiency of biological process can be increased because of uniform characteristics and minimization of the impact of shock loads and toxins during operation. Treatability of the waste water is improved and some BOD reduction and odor removals provided if aeration is used for mixing in the equalization basin A point of return for recycling concentrated waste stream is provided, thereby mitigating shock loads to primary settlers or aeration basin	**½ each**	**3 minutes**
2	Paper production requires a disintegration of the bulky fibrous material to individual or small agglomerate fibers. This is called Pulping. The requirement of a good raw material for pulp and paper production are as follows: i) The ideal fiber for high grade paper should be long i.e. fiber must be long. ii) High in cellulose content. iii) Low in lignin content	**1** **1**	**3 minutes**

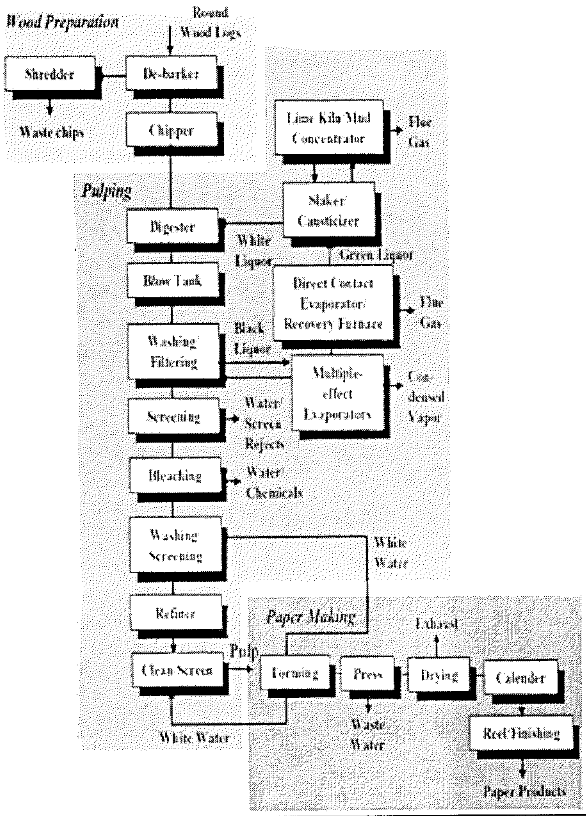
3	The three bye products of sugar industries are; Bagasse, Press Mud and Molasses The Industries which are using these as raw material are, Pulp and paper, Agriculture, Distillery	**1** **1**	**2 minutes**
4	To protect municipal sewage treatment using chemicals from being impaired by a sudden overdose of chemicals contained in the industrial waste To protect biological treatment devices from strong loads of industrial wastes, which may inactivate the bacteria To minimize fluctuations of sanitary standards in the treated effluent	**2**	**3 minutes**

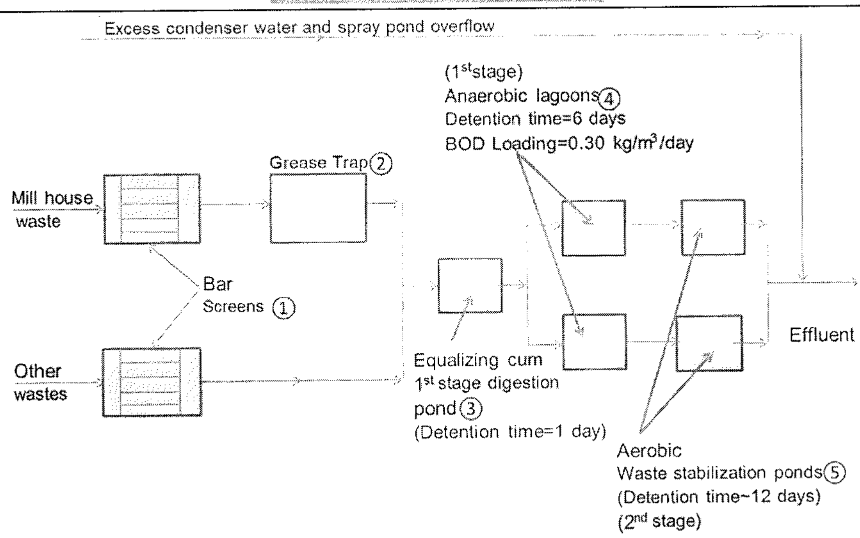
Part B

(2Q x6 M = 12 Marks)

Q No	**Solution**	**Scheme of Marking**	**Max. Time required for each Question**
5	**Conservation of Wastewater** Water conservation is waste saved. Conservation begins when an industry changes from an "open" to a "closed" system. Example: A paper mill that recycles white water (i.e., water passing through a wire screen upon which paper is formed) and thus reduces the volume of wash waters it uses is practicing water conservation. **Changing Production to Decrease Wastes** Changing production to decrease wastes is an effective method of controlling the volume of wastes but is difficult to put into practice. Normally, the operational phase of engineering is planned by the chemical, mechanical, or industrial engineer whose primary objective is cost savings. The main considerations of the environmental engineer, on the other hand, include the protection of public health and the conservation of a natural resource. The engineer can also mention that balancing the quantities of acids and alkalis used in a plant often results in a neutral waste, along with saving chemicals, money, and time spent in waste treatment. **Elimination of Batch or Slug Discharges of Process Wastes** In "wet" manufacturing of a product, one or more steps are sometimes repeated, which results in production of a significantly higher volume and strength of waste during that period. If this waste is discharged in a short period, it is usually referred to as a slug discharge.	2 marks each	**9 minutes**
6	**Equipment modification:** Usually by reducing the amounts of contaminants entering the waste stream. For example in the dairy industry, the new cans were constructed with smooth necks so that they could be drained faster and more completely. This prevented a large amount of milk waste from entering streams and sewage plants. **Segregation of wastes:** waste having strong and smaller in volume is segregated with waste having weaker in concentration and larger volume. For example segregation of cooling water and storm water from process waste. **By-product recovery:** All waste contain by product, so a recovery plant will produce a marketable by product and at the same time solve a troublesome problem.	2 marks each	**6 minutes**

Part C (2Q x 10M = 20 Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time required for each Question</th></tr>
<tr><td>7</td><td>
</td><td>6 marks for diagram

4 marks for explanation</td><td>18 Minutes</td></tr>
<tr><td>8</td><td>
</td><td>5 marks for diagram

5 marks for explanation</td><td>12 minutes</td></tr>
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Roll No												

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20

Course Code: CIV 316

Course Name: Industrial Wastewater Treatment

Program & Sem: B.Tech (Civil) & VII (DE-I)

Date: 20 Dec 2019

Time: 9:30 AM to 12:30 PM

Max Marks: 80

Weightage: 40 %

Instructions:

(i) Read all the questions carefully and answer accordingly.
(ii) Answer all the questions
(iii) Use of Non-programmable calculators is permitted
(iv) Assume suitable data, if necessary, by stating it clearly

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Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 4 marks. (8Qx2M=16M)

1. The dissolved oxygen in an unseeded sample of diluted wastewater having an initial DO of 9.0 mg/L is measured to be 3.0 mg/L after 5 days. The dilution fraction is 0.03 and reaction rate constant k = 0.22 day-1. Identify the data given, to ascertain what the content in the sample is. Calculate a) 5 day BOD of the waste, b) ultimate carbonaceous BOD, and c) What would be remaining oxygen demand after 5 days? (C.O.No.1) [Knowledge]

2. What is Denitrification in the Wastewater Treatment System (C.O.No.3) [Knowledge]

3. With a neat graph list the differences between first stage and second stage BOD curve? (C.O.No.1) [Knowledge]

4. What is Pulping and state three ideal requirement of a good raw material for Pulp and paper production. (C.O.No.2) [Knowledge]

5. What is the necessity of including neutralization unit in industrial wastewater treatment plant? (C.O.No.2) [Knowledge]

6. What is proportioning of industrial waste enhances the effectiveness of effluent treatment plant (C.O.No.2) [Knowledge]

7. With flow diagram explain the activated sludge process. (C.O.No.3) [Knowledge]

8. What are the effects of industrial effluents on sewage treatment plants?

   (C.O.No.1) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 6 marks. **(4Qx6M=24M)**

9. The industries release the effluents containing large variety of pollutants/materials into water bodies making them polluted. Explain the variety of materials those causes the streams pollution. (C.O.No.1) [Comprehension]

10. Based on the concept of sustainable development, we need to ascertain that development and environment to complement each other. The regulatory bodies CPCB and SPCB monitor the effluents discharged by the industries on regular basis referring to the general standards as per the Schedule-VI of The Environment (Protection) Act, 1986. Provide any six Pollutants industrial effluents standards recommended to discharged into inland surface, and on land for irrigation. (C.O.No.1) [Comprehension]

Read the following paragraph carefully and answer the questions number 11 and 12

On 9/12/2019, an industrial visit has been organized to two industries and one CETP located in Doddaballapur industrial area. You have taken keen interest and interacted actively witl the industry person during walk through the industry. The Jodhani Paper Pvt Ltd 100 TPD Paper recycling plant and EGSSPL It is an NABL accredited, MoEF &CC recognized laboratory, equipped with instruments and equipment's wherein we can analyse Air, water, soil, sludge samples to provide trouble shooting solutions in the ROM of ETPs. Manufacturing of Air pollution monitoring equipment's. CETP: it's a Physico-Chemical Processes to treat inorganic waste generated by hundreds of industries. Design capacity: 120 KLD Consented capacity: 100 KLD. The aim of the treatment is to remove pollutants from the wastewater and render it fit for safe discharge to the environment. In view of the increasing demand for the water and its decreasing availability, mere "end-of-pipe' treatment is not the answer to pollution control. Reuse, recycling and where feasible, by-product recovery must become an integral part of the treatment scheme. Experience shows that it is possible to achieve this goal without incurring heavy expenditure. In many cases, the practice of reuse, recycling and by-product recovery has resulted in not only meeting the operating costs, but also offering an attractive payback to the industry.

11. After reading the paragraph given in the above box, explain with flow diagram the manufacturing process of packaging paper from recycled paper in Jodhani Paper Pvt Ltd. Indicating the waste generation points. The General Manager while explaining the process mentioned that this industry is zero effluent discharge industry, what do you meant by this? (C.O.No.2) [Comprehension]

12. Referring to the contents of paragraph given in box, the capital investment and running, operation and maintenance (ROM) costs can be achieved usually by reducing the amounts of contaminants entering the waste stream. Explain the methods for volume reduction practiced in these industries. (C.O.No.3) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries 10 marks. **(4Qx10M=40M)**

13. A wastewater treatment plant disposes of its effluent in a surface stream Characteristics of the stream are flow (m3/s) 10; Dissolved oxygen, mg/L 8; Temperature, °C 20.2; BOD5 at 20°C, mg/L 2 and the characteristics of effluent are flow (m3/s) 0.4; Dissolved oxygen, mg/L 1; Temperature, °C 15; BOD5 at 20°C, mg/L 100. Take Oxygen consumption rate (K1 at 20°C) (1/day) 0.2 and Oxygen reaeration rate (K2 at 20°C) (1/day) 0.3. Identify the data given to ascertain the status of the stream after releasing the effluent into it.

    Calculate: i) What will be the dissolved oxygen conc. in the stream after 2 days?

    ii) What will be the lowest dissolved oxygen concentration as a result of the waste discharge? (C.O.No.1) [Application]

14. Describe the manufacturing process of Sugar industry with net flow diagram indicating the waste generation points and also tabulate the combined wastewater characteristics. (C.O.No.2) [Application]
15. With neat flow diagram describe the manufacturing process of Dairy industry, indicating the wastewater and bye product generation points. (C.O.No.2) [Application]

16. Explain the processes of treatment with block diagram of effluent treatment plant (ETP) for the Tannery industry. (C.O.No.2) [Application]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	1	1 Basics of Industrial Wastewater	2			2
2	1	1 Basics of Industrial Wastewater	2			2
3	1	1 Basics of Industrial Wastewater	2			2
4	1	2 Characterization of Industrial Wastewater	2			2
5	1	2 Characterization of Industrial Wastewater	2			2
6	1	2 Characterization of Industrial Wastewater	2			2
7	1	3 Unit Operations and Processes	2			2
8	1	3 Unit Operations and Processes	2			2
9	2	1 Basics of Industrial Wastewater		6		6

10	2	1 Basics of Industrial Wastewater		6		6
11	2	2 Characterization of Industrial Wastewater		6		6
12	2	2 Characterization of Industrial Wastewater		6		6
13	3	3 Unit Operations and Processes			10	10
14	3	3 Unit Operations and Processes			10	10
15	3	1 Basics of Industrial Wastewater			10	10
16	3	3 Unit Operations and Processes			10	10
	Total Marks		16	24	40	80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

(Dr. Jagdish H. Godihal)

Reviewer Comment:

Format of Answer Scheme

SCHOOL OF ENGINEERING

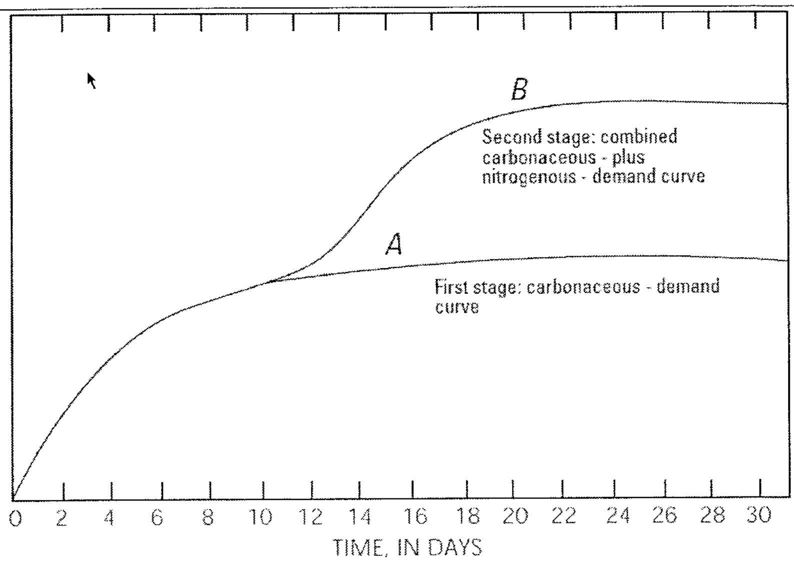
SOLUTION

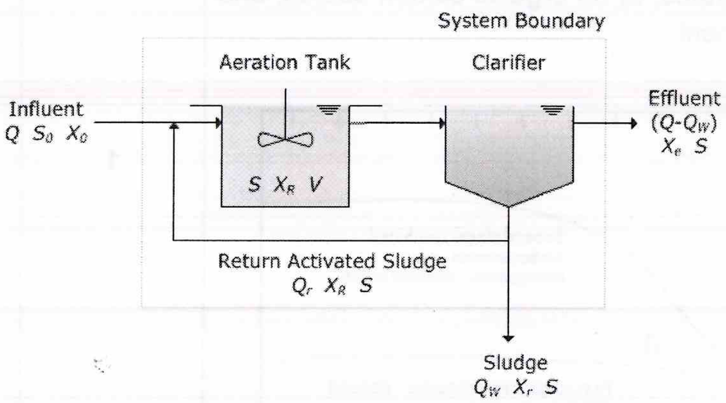
GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: Odd Semester: 2019-20
Course Code: CIV316
Course Name: Industrial Wastewater Treatment
Program & Sem: B.Tech (Civil) & VII (DE-I)

Date: 20 Dec 2019
Time: 9:30 AM to 12:30 PM
Max Marks: 80
Weightage: 40%

Part A (2Q x 8M = 16Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	a) Oxygen demand for first 5 days BOD5 = (DOi – Dof) / p = (9.0 – 3.0) / 0.03 = 200 mg/L b) Ultimate BOD BODu = Lo = BODt / (1 – e-kt) = 200 / (1 – e-0.22 x 5) = 300 mg/L c) After 5 days, 200 mg/L of oxygen demand out of total 300 mg/L would be satisfied. Hence, the remaining oxygen demand would be 300 – 200 = 100 mg/L	1 1	**5**
2	Denitrification is the biological process by which nitrate is converted to nitrogen and other gaseous end products. The requirements for the Denitrification process are: a) nitrogen present in the form of nitrates; b) an organic carbon source, and c) an anaerobic environment	**2**	**5**
3		**1**	**5**

	There are two stages of decomposition in the BOD test: a carbonaceous stage and a nitrogenous stage. The carbonaceous stage, or first stage, represents that portion of oxygen demand involved in the conversion of organic carbon to carbon dioxide. X The nitrogenous stage, or second stage, represents a combined carbonaceous plus nitrogenous demand, when organic nitrogen, ammonia, and nitrite are converted to nitrate. While the nitrogenous oxygen demand generally begins after about 6 days	1	
4	Paper production requires a disintegration of the bulky fibrous material to individual or small agglomerate fibers. This is called Pulping. The requirement of a good raw material for pulp and paper production are as follows: i) The ideal fibers for high grade paper should be long i.e. fibers must be long. ii) High in cellulose content. iii) Low in lignin content	1 1	5
5	The efficiency of biological process can be increased because of uniform characteristics and minimization of the impact of shock loads and toxins during operation. Treatability of the waste water is improved and some BOD reduction and odor removals provided if aeration is used for mixing in the equalization basin A point of return for recycling concentrated waste stream is provided, thereby mitigating shock loads to primary settlers or aeration basin	2	5
6	To protect municipal sewage treatment using chemicals from being impaired by a sudden overdose of chemicals contained in the industrial waste To protect biological treatment devices from strong loads of industrial wastes, which may inactivate the bacteria To minimize fluctuations of sanitary standards in the treated effluent Equalization improves sedimentation efficiency by improving hydraulic retention time.	2	5
7	 ASP is an biological, aerobic, suspended growth process, wherein the biodegradable organic matter decomposed by aerobic microorganisms in presence of DO.	1 1	5
8	To protect municipal sewage treatment using chemicals from being impaired by a sudden overdose of chemicals contained in the industrial waste	2	5

	To protect biological treatment devices from strong loads of industrial wastes, which may inactivate the bacteria To minimize fluctuations of sanitary standards in the treated effluentbacteria, which comprises the greater proportion of the biomass in both fixed film and suspended growth systems. The key requirement for nitrification to occur, therefore, is that the process should be so controlled that the net rate of accumulation of biomass, and hence, the net rate of withdrawal of biomass from the system, is less than the growth rate of the nitrifying bacteria.		

Part B (4Q x 6M = 24 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
9	Inorganic salts: Inorganic salts, which are present in most industrial wastes as well as in nature itself, cause water to be "hard" and make a stream undesirable for industrial, municipal and agricultural usage. Another disadvantage is that, under proper environmental conditions, inorganic salts especially nitrogen and phosphorous induce the growth of microscopic plant life (algae) in surface waters Acids and /or Alkalis: Acids and Alkalis discharged by chemical and other industrial plants make a stream undesirable not only recreational uses such as swimming and boating, but also for propagation of fish and other aquatic life. High concentrations of sulfuric acid, sufficient to lower the pH below 7.0 when free chlorine is present, have been reported to cause eye Organic matter: Organic Matter exhausts the oxygen resources of rivers and creates unpleasant tastes, odours and general septic conditions. It is generally conceded that the critical range for fish survival is 3to 4 mg/l of D.O certain organic chemicals such as phenols, affect the taste of domestic water supplies. Suspended solids, Floating Solids and liquids, heated water, Colour, Microorganisms, Radioactive materials, Foam producing materials, Toxic chemicals	1 x 6	10
10	Inland surface water; Land for irrigation Suspended solids mg/l, Max. 100 200 pH Value 5.5 to 9.0 5.5 to 9.0 Oil and grease mg/l Max. 10 10 Total residual chlorin mg/l Max. 1.0 -- -- Ammonical nitrogen (as N), mg/l Max. 50 -- Total Kjeldahl Nitrogen (as NH3) mg/l, Max. 100 - Free ammonia (as NH3) mg/l, Max. 5.0 – Biochemical Oxygen demand 1 [3 days at 27^0 C] mg/l max. 30 100 Chemical Oxygen Demand, mg/l, max. 250 250 Arsenic (as As), mg/l, max. 0.2 0.2 Mercury (as Hg), mg/l, Max. 0.01 0-	½ x 6 ½ x 6	10
11	100 TPD capacity Pulp section, Paper section, white water reuse	3x2	10

	Zero discharge effluent means no effluent, emissions and solid waste goes out of industrial premeses, whereas it is reused, recycled and recovered within the manufacturing/ after minor treatment within industry premesis.		
12	**Conservation of Wastewater** Water conservation is waste saved. Conservation begins when an industry changes from an "open" to a "closed" system. Example: A paper mill that recycles white water (i.e., water passing through a wire screen upon which paper is formed) and thus reduces the volume of wash waters it uses is practicing water conservation. **Changing Production to Decrease Wastes** Changing production to decrease wastes is an effective method of controlling the volume of wastes but is difficult to put into practice. Normally, the operational phase of engineering is planned by the chemical, mechanical, or industrial engineer whose primary objective is cost savings. The main considerations of the environmental engineer, on the other hand, include the protection of public health and the conservation of a natural resource. The engineer can also mention that balancing the quantities of acids and alkalis used in a plant often results in a neutral waste, along with saving chemicals, money, and time spent in waste treatment. **Elimination of Batch or Slug Discharges of Process Wastes** In "wet" manufacturing of a product, one or more steps are sometimes repeated, which results in production of a significantly higher volume and strength of waste during that period. If this waste is discharged in a short period, it is usually referred to as a slug discharge	2 x 3	10

Part C (4Q x 10M = 40Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
13	(see table below)	3	15

Parameter	wastewater (given)	stream (given)	Wastewater and stream water mixture
flow (m^3/s)	0.2	5	$=Q_{mixture}=10+0.4=10.4$ m/s
Dissolved oxygen, mg/L	1	8	$DO_{mixture}=(0.4*1+8*10)/(10+0.4)$ =7.73 mg/L
Temperature, °C	15	20.2	$Temp_{mixture}=(0.4*15+20.2*10)/(10.4)$ =20 deg C (No temp. correction required)
BOD_5 at 20°C, mg/L	100	2	$BOD_{mixture}=(0.4*100+2*10)/(10.4)$ =5.77 mg/L
Oxygen consumption rate (K1 at °C) (1/day)	0.2		0.23 (No temp. correction required) (assumed for stream water)

Oxygen reaeration rate ($K2$ at °C) (1/day)	-	0.3	0.3 (No temp. correction required)

Ultimate BOD= $Y_{ultimate}=L_0$ = (5-day BOD in mixture water)/[1-exp(-$K1_{mixture}$*5)]
=(5.77 mg/L)/ [1-exp(-0.23*5)] =8.44 mg/L

Initial DO deficit (D_0)
For 20°C stream water temperature, equilibrium concentration of oxygen =9.17 mg/L D_0 = 9.17 mg/L-7.73 mg/L = 1.44 mg/L

To get DO after 2 days in stream water after mixing, we need to calculate DO deficit after 2 days first and then calculate DO (at 2days). DO deficit at 2 days is given by
D (t=2 days) = [K1*L_0]*[exp (-K1*t)-exp (-K2*t)]/ (K2-K1) + D_0 exp (-K2*t)
= [0.2*8.44]*[exp (-0.2*2)-exp (-0.3*2)]/ (0.3-0.2) + 1.44 exp (-0.3*2)
= [1.94]*[0.6703-0.5488]/ (0.07) + 0.7903 =3.07 mg/L

D (t=2 days) = DO $_{saturated}$-DO (2day) = 3.07 mg/L
DO (2day) = 9.17-3.07=**6.10 mg/L (answer for part i)** — 4

Time for critical DO deficit (t_c)= 1/ (K2-K1)*ln [(K2/K1)*(1-D_0 *(K2-K1)/ (K1L_0))]
= 1/ (0.3-0.23)*ln [(0.3/0.23)*(1-1.44 *(0.3-0.23)/ (0.23*8.44))]
= 14.29*ln [1.3*(1-1.44 *0.036)] = 14.29*ln [1.23] =2.95 days
Critical DO deficit (D_c)= (K1/K2)*L_0 exp (-K1*t_c)
= (0.23/0.3)*8.44 exp (-0.23*2.95) = 6.47 *0.507 =3.28 mg/L

D_c = $DO_{saturated}$-$DO_{critical}$ = 3.28 mg/L

$DO_{critical}$= 9.17-3.28=**5.89 mg/L (answer for part ii)** — 3

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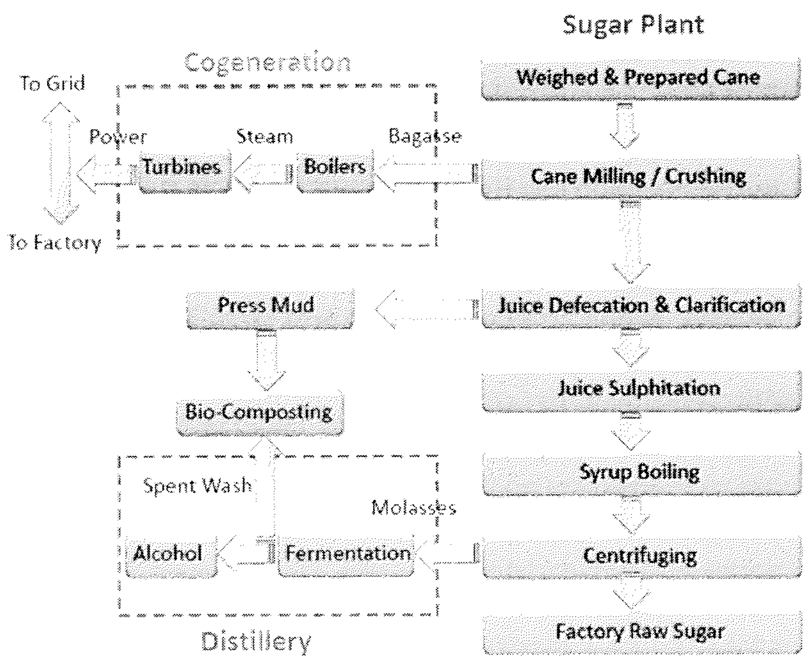
14 | 5 marks for diagram | 15



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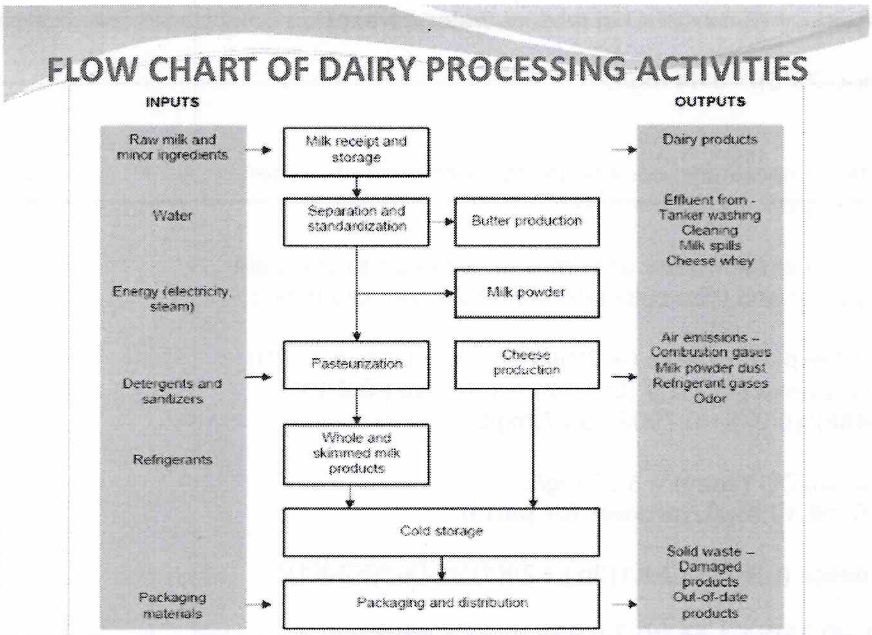
<tr><td>15</td><td>
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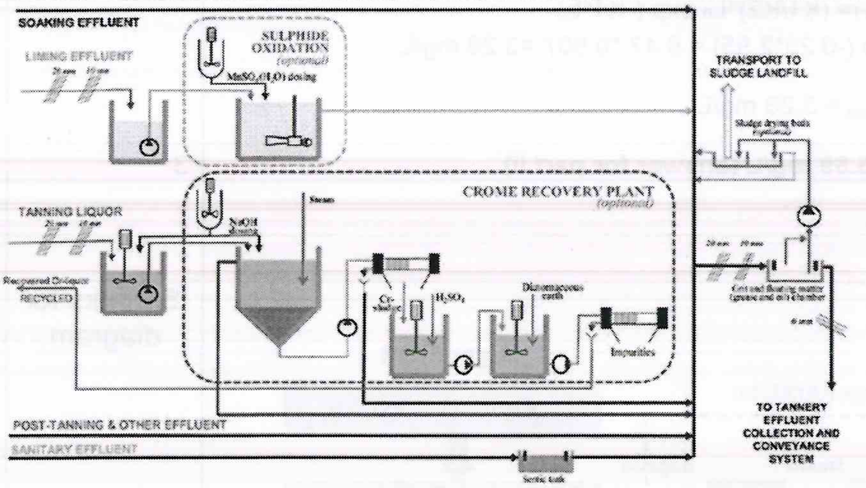
<tr><td>16</td><td>
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