King Saud University **CE 442 Water Treatment**
College of Engineering **2nd Semester**
Civil Engineering Department **Section:**

First Mid-term Exam

Part one *(close book). Time allowed: 35 minutes*

Student Name: ……..
Student Number: ……..

Question One (20%)

For each statement, circle the most appropriate answer

(a) True .color of water is caused by:
a. dissolved solids. b. suspended solids. c. both a and b

(b) As the hydrogen ion concentration in solution increases, the pH:
a. increases b. decreases. c. stays as is.

(c) Solids left in a porcelain dish .after evaporation at 104.°C of a measured volume of a filtered water sample, is called:
a, suspended solids. b. total solids. c. dissolved solids.

(d) Conductivity of water can be used as a rough measure of:
a. total suspended solids, b. total dissolved solids. c. turbidity

(e) Alkalinity of natural water results from the presence of:
a. nitrates. b. carbon dioxides, c. bicarbonates

(f) Highly alkaline water often has:
a. a low level of dissolved solids. b. a high level of suspended solids.
c. a high level of dissolved solids.

(g) Permanent hardness of water is caused by presence of calcium and magnesium:
a. sulfates and chlorides. b. carbonates and bicarbonate,
c. bicarbonates and sulfates.

(h) Discharge of water containing high levels of ammonia nitrogen into water bodies is not desirable because ammonia:
a. is toxic to aquatic life. b. lowers the dissolved oxygen concentration.
c. both a and b.

(i) Eutrophication of water bodies is due to the presence of excessive concentrations of:
a. iron and manganese. b. nitrogen and phosphorus .
c. calcium and magnesium.

(j) For domestic wastewater:
a. BOD5>COD. b. BOD5 < COD c. BOD5 = COD

(k) Coliform bacteria are:
a. pathogenic b. not pathogenic. c. toxic

(1) The membrane-filter technique for the enumeration of colifonns in water:
a. gives a statistical estimate of coli forms.
b. gives a direct count of coli forms. c. both a and b.

(m) Cholera is a:
a. bacterial disease b. viral disease c. protozoan disease

(n) Groundwater is usually:
a. open to pollution. b. free of turbidity c. free of dissolved gases.

(o) Within homes, water used for toilet flushing and 'bathing accounts for almost:
a. 10% of total domestic use. b. 20% of total domestic use.
c. 80% of total domestic use.

(p) The design capacity of water treatment plants is based on the:
a. maximum hourly demand. b. maximum daily demand.
c. average daily demand.

(q) Addition of alum (aluminum sulfate) to water:
a. reduces the alkalinity. b. increases the pH. c. increases the alkalinity.

(r) Aeration of groundwater can remove:
a. soluble compounds. b. dissolved gases c. pathogens

(s) Design perimeters tot govern the efficiency of gravity settling basins are:
a. the overflow rate. b. the detention time. c. both a and b.

(t) Volatile solids of a water sample is a measure of the;
a. organic content. b. inorganic content. c. both a and b

Question Two (20%)

Answer with true (T) or false (F):

(1) A turbidimeter measures the clarity of tap water.

(2) If an atom losses electrons, the atom 'becomes positively charged and the atom is reduced.

(3) Very hard water- tends to be corrosive.

Question Three (12%)

The curve shown below is the results of a chlorine demand test on a raw drinking water at 20 °C and 10-minutes contact time. Determine the following:

(1) the breakpoint chlorine dosage,

(2) the free residual at a chlorine dosage of 0.9 mg/L,

(3) the chlorine demand at a dosage of 1.0 mg/L.

Question Four (12%) :

A sand-filtration unit 5.0 m by 10.0 m with four washing troughs treats 12.000 m3/day. The unit is backwashed once a day at a rate of 15 l/m2. Sec for 10 minutes calculate (1) the filtration rate, (2) the quantity of water used in backwashing, and (3) the flow rate of wash-water in each trough.

King Saud University **CE 442 Water & Wastewater Treatment**

College of Engineering **First Semester**

Civil Engineering Department **Section:**

Final Examination

Time allowed: three hours

Question One (20%)

Choose only 4 out of the following five questions:

(1) Draw a schematic diagram for Al-Shumasi water treatment plant showing all units and processes and indicate the purpose of each unit and process.

(2) Answer with True or False:

(a) Sludge processing accounts for 30% to 40% of the capital and operating costs of wastewater treatment plants.

(b) Chloramines are more effective for disinfection than free-available chlorine and they persist longer in the treated water.

(c) Bulking sludge is a sludge that floats or rises to the surface after apparently good settling.

(d) If sludge is thickened from 2% to 4%, the sludge volume is reduced by one-half.

(e) Waste activated sludge is the portion of the settled solids in the final clarifiers that is returned to the aeration tanks.

(3) What is meant by drinking water standards? , and outline their significance?

(4) What are pathogens? and how water is tested for pathogen?

(5) What is eutrophication? What are its impacts on the aquatic environment?

Question Two (15%)

* The BOD_5 of a wastewater is determined to be 150jng/L at 20 °C. The K« value is known to be 0.23 per day. What would the BOD_3 be if the test were run at 15"C.?

Question Three (12%)

* A water with a turbidity of20NTU requires 30 mg/L of alum as coagulant. The natural alkalinity of the water is 6.0 mg/L as $CaCO_3$. (a) Do we need to add alkalinity to this water? If yes, what to add and how much you need to add. (b) How many milligrams of sludge solids produced per liter of water?

Question Five (13%)

A conventional activated-sludge system treats 100,000 m^3/day of municipal wastewater with a BOD of 180 mg/l, the design F/M ratio is 0.3 day^{-4}. The MLSS concentration of the 24,000 m aeration tanks was measured and found to be 1800 mg/L. Is the system organically overloaded? If so, how might the situation is rectified?

Question Six (18%) .

A single-stage trickling-filter plant is to be constructed for a small municipality. The expected average and peak flows are 20,000 m /day and 30,000 m3/day, respectively. The SS and BOD concentrations of the raw wastewater at the average flow are 220 mg/L and 200 mg/L, respectively. Determine the dimensions required for:

(a) Two circular primary tanks 3 meter deep and having an overflow rate not exceeding 60 m /m .day and a detention time of at least 1.0 hour at peak flow.

(b) Two circular biological filters of random-plastic media. Use design BOD and hydraulic loadings of 2.0 kg/m3.day and 50-90 m3/m2/day, respectively. The media depth should be between 4 to 6 meter. Assume a BOD removal of 30% in the primaries.

Question Seven (10%)

Two completely-mixed aerated lagoons are being considered for pre-treatment of an industrial wastewater of 6000 m^3/day with a BOD of 600 mg/L. The design should provide a BOD reduction of 70% at a temperature of 10 "C. The laboratory studies showed that K_2o of this wastewater is 0.7 day^{-1}. Determine the surface area needed for each unit for a water depth of 2.0 meter. In these computations assume no evaporation or seepage losses from the lagoons.

King Saud University **CE 442 Water & Wastewater Treatment**

College of Engineering **First Semester**

Civil Engineering Department

Final Examination (Open Book)

Time allowed: 2.5 hours

Question One (33%)

(A, 18%) Briefly answer each of the following in point form using sketches and/or equations where possible:

(1) Why disinfection of water by chlorine is more effective at low pH.

(2) Why sludge is conditioned.

(3) Why treatment of water by alum decreases the pH.

(4) Why water is recarbonated by CO_2 after excess-lime treatment.

(5) What advantages do plastic media have over stone media in trickling filtration of wastewater?

(6) What are the potential operational problems associated with the use of stabilization ponds for wastewater treatment

(7) In the activated sludge process, why a portion of the settled solids in the secondary clarifier is returned to the aeration tank

(B, 15%) Note one method only (without explaining) by which each of the following can be reduced:

(1) Taste and odor in drinking water.
(2) Iron and Manganese in drinking water.
(3) Algae growth in surface water.
(4) Turbidity caused by clay, in water.
(5) Dissolved organic matter in wastewater.
(6) Suspended solids in effluents from conventional wastewater-treatment plants.
(7) Dissolved gases in drinking water.
(8) Nitrates in drinking water.
(9) Organic solids in sludge
(10) Salts in drinking water

Question Two (14%)

A BOD analysis of a wastewater yielded the following results. Determine the reaction rate constant k (base e) and the ultimate BOD.

Time (day)	0	1	2	3	4	5
BOD (mg/L)	0	65	109	138	158	172

- The characteristics of the mixed liquor as determined in the-laboratory are; MISS = 2500 mg/L. and the sludge volume after 30-min settling' in a 1-L graduated cylinder = 180 ml.

(B) If the MLSS is increased to 3500 mg/L, what will be the F/M ratio? Suggest a means to increase the MISS lo 3500 mg/L (i.e. how it can be done)

Question Three (10%)

Note one method only (without explaining) by which each of the following can be reduced/controlled:

(1) Dissolved organic matter in wastewater.
(2) Dissolved gases in drinking water.
(3) Algae growth in surface water.
(4) Fecal coliform in wastewater.
(5) Water in digested sludge.
(6) Organic solids in sludge.
(7) Fly breeding in trickling filters.
(8) Excess calcium and magnesium concentrations in drinking water.
(9) Volatile organics in drinking water.
(10) inorganic particles in sanitary wastewater

*** Question Five (15%)**

Determine the activated-sludge aeration volume required to treat 12,000 m3/day with a BOD of 110 mg/L based on the criteria of a maximum BOD loading of 600 g/m3.doy and a minimum aeration period of 3.0 hours.

If the operating F/M ratio of 0.25 g BOD/day per g of MISS is to be maintained in the aeration tank, calculate the suspended solids concentration of the mixed liquor. What would be the solids concentration in the return-sludge if the return flow is -3000 m^3/day? Calculate also the sludge age if the wastage from the return line is 40 m^3 /day.

*** Question Sex (8%)**

A completely mixed aerated lagoon is being considered for pre-treatment of a strong industrial wastewater with k = 0.6 day^{-1} at 20 °C and θ = 1.04, using a detention time of 5 days. What is the BOD reduction at 20 °C.? If the wastewater temperature is 10 °C, what is the detention/lime required to achieve the same degree of treatment.

*** Question Seven (6 %)**

Calculate the volume of a waste sludge with 96% water content containing 500 kg of dry solids. If the moisture content is reduced to 92%, what is the sludge volume?

King Saud University **CE 442 Water & Wastewater Treatment**

College of Engineering **First Semester**

Civil Engineering Department

Final Examination (Open Book)

Time allowed: Three hours

Question One (10%)

In a BOD determination of a wastewater, 6 mL of the waste witb^zero dissolved oxygen are mixed with 294 mL of diluting water containing 8.16 mg/L of dissolved oxygen. After incubation for 5 days, the dissolved oxygen content of the mixture is 5.4 mg/L (a) Calculate theBOD5ofthe wastewater. (b) How much oxygen (kg/day) is required to satisfy the BOD demand of 8000 m3/day of this waste, assuming that 1.0kg of oxygen is to be supplied per kg of ultimate BOD in the waste, and that k = 0.12 per day (base 10).

Question Two (15%)

The results of a chlorine demand test on raw water at 20 °C and 15 minutes contact time are as follows:

Chlorine dosage (mg/L)	1	2	3	4	5	6	7	8	9	10	11
Residual chlorine (mg/L)	0.5	1.0	2.0	3.0	4.0	3.5	2.5	2.0	3.0	4.0	5.0

(a) Sketch the chlorine demand curve, (b) What is the break-point chlorine dosage, (c) What is the chlorine dosage necessary to achieve a combined residual of 4.0 mg/L. (d) What is the chlorine dosage necessary to achieve a residual of 4.0 mg/L free and combined chlorine, (e) What is the chlorine dosage necessary to achieve a residual of 1.0 mg/L free available chlorine

Question Three (15%)

A single-stage trickling filter plant consists of a primary clarifier, a trickling filter 2 1 m in diameter with a 2-m depth of random packing, and a final clarifier. The raw-wastewater flow is 3028 m^3/day with 200 mg/L of BOD5 and a temperature of 15 °C. The constants for the random-plastic media are an "n" of 0.4 and "k20" of 0.3 hour'". Assuming 35% BOD removal in the primary, calculate the effluent BOD concentration (a) without recycle, and (b) with a recirculation of 15 14 m^3/day.

Question Four (15%)

Determine the capacity of two aeration tanks of an activated sludge system required to treat 6000 m^3/day with a BOD3 of 120 mg/L if detention time must be at least 4.0 hours, F/M ratio must not exceed 0.3, and an MLSS concentration of 1800 mg/L will be maintained. Estimate the sludge age assuming excess suspended solids production of 0.45 g of MLSS per g of BOD applied.

Question Five (10%)

Two completely-mixed aerated lagoons operating in parallel are proposed to treat an average flow of 7100 m/day with a BOD5 of 200 mg/L... The temperature extremes anticipated for the lagoon contents range from 18_TJn_winter to 40 °C in summer. Minimum BOD reduction through the lagoon should be 80%. Laboratory treat ability studies showed that k20 of this waste = 0.8 day"1.

Assuming a water depth of 2.5m, what are the required surface area and detention period of each \ lagoon.

Question Sex (5%)

Draw schematic of a conventional activated-sludge plant showing all units and processes involved in the treatment of wastewater and sludge, and specify the function of each treatment unit.

Question nine (10%)

Answer with True (T) or False (F)

1- Water from wells is more likely to contain H2S and be higher in dissolved. Solids than surface water supplies.
2- Disinfection with chlorine is more effective at a pH of 7.5 than at pH 6.5.
3- A rate of flow controller on a gravity water filter allows a higher filtration rate when the filter is clean than when it is dirty.
4- Gravity thickening is used primarily on waste activated sludge.
5- Sludge that has good settling characteristics is called bulking sludge.
6- In the excess-lime softening process, excess lime is added for the removal of calcium hardness.
7- If sludge is thickened from 2% to 4% solids, the volume of sludge is reduced by one-half.

8- Reverse osmosis is the process of diffusion of solvent (water) through a semi-permeable membrane from a solution of a lower to one of a higher concentration.

9- Chloramines are more effective for disinfection than free-available chlorine and they persist longer, in the treated water.

10- The presence of coliform bacteria indicates that pathogenic bacteria are present.

11- Sludge processing deals with less 1% of the total waste volume but accounts for 30 to 40 percent of the capital and operating costs of waste treatment.

12- Potassium permanganate is an effective chemical in oxidizing many odor and taste producing compounds.

13- Waste activated sludge is the portion of the settled solids in the final .clarifier that is returned to the aeration tank.

14- Turbidity is a measure of the suspended solids concentration.

15- The main disadvantage of anaerobic treatment of wastewater is the large production of sludge.

16- Stabilization ponds are suitable for treating small flows of wastewater.

17- In water treatment, granular-media filtration must be preceded by chemical coagulation.

18- Water with a total dissolved solids concentration of about 30,000 ppm is "called brackish water.

19- Due to low pH involved excess-lime softening assists in removing pathogens if any is present.

20- The main objective of the secondary treatment of wastewater is to reduce the content of soluble colloidal inorganic remaining after primary treatment.

King Saud University **CE 442 Water & Wastewater Treatment**

College of Engineering **First Semester**

Civil Engineering Department

Final Examination (Open Book)

Time allowed: 1 $^{1}/_{2}$ hours

Question One (20%)

A small town produces 20,000 m^3/day of wastewater on the average. The peak flow is 1.75 times the average.

(a) Design a git-rermoval system consisting of two identical chamber 2.0 m deep to process the peak flow. The flow-through velocity is to be controlled at 0.2 m/s by a down stream proportioning weir, and the settling velocity is to be maintained at 0.1 m/s. Determine also the design detention time.

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(b) Design a primary clarification system with at least two tanks 2.0 m deep provided that the overflow rate should not exceed 70 rn^3/m^2 day at the peak flow and the detention time should be at least 1.0 hour.

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Question Two (20%)

A single-stage trickling filter plant is proposed for treating a-municipal wastewater flow of 4000 m^3/d with an average BOD of 35% mg/L. Assuming 35% BOD removal in the primary settling tanks, calculate the size required for two 3-m deep filters operating in parallel with a BOD loading of 500 g/m^3 d.

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Question Three (20%)

- Determine the activated aeration volume required to treat 12.000 m^3/day with a BOD5 of 110 mg/L based on the criteria of a maximum BOD loading of 600 g/m^3.day and a minimum aeration period of 3 hours.
- If the operating F/M ratio of 0.25g BOD/day per g MLSS is to be maintained in the aeration tank, calculate the suspended solids concentration of the mixed liquor (MLSS),
- What would be the solids concentration in the return sludge if the return flow is 3000 m^3/day?
- Calculate also the sludge age if the wastage from the return line is 40 m^3/day.

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Question Four (20%)

- Estimate the mass (kg/day) and volume (m^3/day) of the waste activated sludge from an activated sludge treating 15,000 m^3/day of wastewater with a settled BODs of 130 mg/L operating at a F/M ratio of 0.24 g BODs per day g MLSS. The suspended solids in the waste sludge withdrawn from the return sludge pipe are 9000 mg/L.
- If the waste sludge is thickened to 3% what is the volume of the thickened sludge?

King Saud University **CE 442 Water & Wastewater Treatment**

College of Engineering **First Semester**

Civil Engineering Department

Second Mid-term Exam

Time allowed: 1 $^{1}/_{2}$ hour

Question One (20%)

A small town produces 20,000 m^3/day of wastewater on the average. The peak flow is 1.75 times the average.

(a) Design a grit-removal system consisting of two identical chambers/^ m deep! To process the peak flow. The flow-through velocity is to be controlled at 0.2 m/s by a down stream proportioning weir, and the settling velocity is to be maintained 0.1 m/s. Determine also the design detention time.

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(b) Design a primary clarification system with at least two tanks 2.0-rn deep provided that the overflow rate should not exceed 70 m3/m^2 day -at the peak flow and the detention time should be at least 1.0 hour.

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Question Two (20%)

A .single-stage trickling filter plant is proposed for treating a- municipal wastewater flow of 4000 m3/d with an average BOD of 300 mg/L. Assuming 35% BOD removal in the primary settling tanks, calculate the size required for two 3-m deep filters operating in parallel with a BOD loading of 500 g/m .d

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Question Two (20%)

- Determine the activated-sludge aeration volume required to treat 12.000 m3/day with a BODs of 110 mg/L based on the criteria of a maximum BOD loading of 600 g/m^3.day and a minimum aeration period of 3 hours.
- If the operating F/M ratio of {0.25jg BOD/day per g MLSS is to be maintained in the aeration tank, calculate the suspended solids concentration of the mixed liquor (MLSS).
- What would be the solids concentration in the return sludge if the return flow is 3000 m3/day?
- Calculate also the sludge age if the wastage from the return line is 40 m^3/day.

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Question Four (20%)

Estimate the mass (kg/day), and volume (m3/day) of the waste activated sludge from an activated sludge process treating 15,000 m /day of wastewater with a settled RODs of 130 mg/L operating at a F/M ratio of 0.24 g BOD5 per day per g MLSS. The suspended solids in the waste, sludge, withdrawn from-the, return sludge pipe are 9000 mg/L. If the waste sludge is thickened to 3% what is the volume of the thickened sludge?

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Question Five (20%)

A completely-mixed aerated lagoon is being considered for pre-treatment of strong industrial wastewater with K= 0.7 per day at 20'°C using a detention time of 5 days, "What is tt^BOD reduction 20 °C (i.e. removal efficiency).

If the wastewater temperature is 10°C, compute the detention time required to achieve the same degree of treatment.

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King Saud University **CE 442 Water & Wastewater Treatment**

College of Engineering **First Semester**

Civil Engineering Department

Second Mid-term Exam

Time allowed: 1 $^{1}/_{2}$ hour

Question One (30%)

The curve shown below is the results of a chlorine demand test on a raw drinking water at 20 °C and 10-minutes contact time. Determine (he following :

(1) The breakpoint chlorine dosage,

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(2) The free residual at a chlorine

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(3) The chlorine demand at a dosage of 1 .0 mg/L,

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Question Two (20%)

Results of a chlorine demand test on raw water are as follows:

Sample no.	Chlorine Dosage (mg/L)	Chlorine Residual (mg/L)
1	0.4	0.1
2	0.8	0.4
3	1.2	0.8
4	1.6	1.0
5	2.0	0.6
6	2.4	0.4
7	2.8	0.6
8	3.2	0.8
9	3.6	1.0

(1) Sketch a chlorine demand curve.

(2) What is the breakpoint dosage?

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(3) What is the chlorine demand at a dosage of 3.0 mg/L?

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Question Three (30%)

A small town needs a wastewater treatment plant to treat its average flow of 7,000 m^3/day. The peak flow is expected to be 18,000 m^3/day.

(1) Design a primary sedimentation system composed of four tanks 2.5-m deep provided that the overflow rate should not exceed 100 m /m .day at the peak flow with a detention time of not less than 1.0 hour.

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(2) If one of the primary tanks is out service, what are the overflow rate and detention time at the peak flow? Check these values with the design values. What can be done if the design values are not met?

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(3) Calculate the *volume* of the primary sludge (m^3/day) if the suspended solids concentration (SS) of the primary influent is 280 mg/L, and a 65% of SS would be removed in the primary tanks. Assume that solids concentration in the primary sludge is 3%.

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King Saud University **CE 442 Water & Wastewater Treatment**

College of Engineering **First Semester**

Civil Engineering Department

First Mid-term Exam

Part One (Close Book) Time allowed: 3 hours

Student Name: ……..

Student Number: …….

Question One (20%)

For each statement, circle the most appropriate answer:

(a) True .color of water is caused by:
a. dissolved solids. b. suspended solids; c. both a and b

(b) As the hydrogen ion concentration in solution increases, the pH:
a. increases. b. decreases. c. stays as is.

(c) Solids left in a porcelain dish .after evaporation at 104 ,°C of a measured volume of a filtered water sample, is called:
a. suspended solids. b. total solids. c. dissolved solids.

(d) Conductivity of water can be used as a rough measure of:
a. total suspended solids. b. total dissolved solids. c. turbidity

(e) Alkalinity of natural water results from the presence of:
a. nitrates. b. carbon dioxides. c.bicarbonates.

(f) Highly alkaline water often has:
a. a low level of dissolved solids. b. a high level of suspended solids. c. a high level of dissolved solids.

(g) Permanent hardness of water is caused by presence of calcium and magnesium:
a. sulfates and chlorides. b. carbonates and bicarbonate.
c. bicarbonates and sulfates.

(h) Discharge of water containing high levels of ammonia nitrogen into water bodies is not desirable because ammonia:
a. is toxic to aquatic life. b. lowers the dissolved oxygen concentration.
c. both a and b.

(i) Eutrophication of water bodies is due to the presence of excessive concentrations of:
a. iron and manganese. b. nitrogen and phosphorus.
c. calcium and magnesium.

(j) For domestic wastewater:'

a. BOD5>COD. b. BOD5<COD. c. BOD5 « COD.

(k) Coliform bacteria are:

a. pathogenic. b. not pathogenic. c. toxic.

(l) The membrane-filter technique for the enumeration of colifoms in water:

a. gives a statistical estimate of colifoms.

b. gives a direct count of coliforms. c. both a and b.

(m) Cholera is a:

a. bacterial disease. b. viral disease. c. protozoan disease.

(n) Groundwater is usually:

a. open to pollution, b. free of turbidity. c. free of dissolved gases.

(o) Within homes, water used for toilet flushing and "bathing accounts for almost:

(p) The design capacity of water treatment plants is based on the:

a. maximum hourly demand. b. maximum daily demand.

c. average daily demand.

(q) Addition of alum (aluminum sulfate) to water:

a. reduces the alkalinity, b. increases the pH. c. increases the alkalinity.

(r) Aeration of groundwater can remove:

a. soluble compounds. b. dissolved gases. c. pathogens

(s) Design parameters that govern the efficiency of gravity settling basins are:

a. me overflow rate:. b. the detention time. c. both a and b.

(t) Volatile solids of a water sample are a measure of the:

a. organic content. b. inorganic content. c. both a and b.

Question Two (20%)

Answer with true (T) or false (F):

(1) A turbid meter measures the clarity of tap water.

(2) If an atom losses electrons, the atom "becomes positively charged and the atom is reduced.

(3) Very hard water tends to be corrosive.

(4) Water with a pH of less than 4.5 has no alkalinity.

(5) Isotopes are elements that have the same number of protons but different number of neutrons.

(6) Water with high alkalinity content has a bitter taste.

(7) Staining of clothes and plumbing fixtures is a direct result of the presence of appreciable amounts of iron and manganese in water.

(8) The organic content of industrial wastewater generated from steel industry can 'be measured by the use of biochemical oxygen demand (BOD).

(9) Once surface water is polluted it is hard and difficult to restore.

(10) Drinking water standards help determining whether "treatment of raw water is required.

(11) Water flocculation is a slow mixing of a suspension containing destabilized colloids to promote the formation offices.

(12) Cold water is easier to coagulate than warmer water.

(13) Addition of alum (aluminum, sulfate) to water increases the water pH.

(14) Industries usually require/use less water than commercial facilities.

(15) Addition of sodium hydroxide to water will increase its pH.

(16) Apparent color of water is caused by suspended solids

(17) Ion-exchange softening reduces water hardness to the practical solubility levels of $CaCO_3$ and $Mg(OH)_2$

(18) The main advantages of dual media filters over single-medium sand filters are longer filter runs and greater filtration rates.

(19) Re-carbonation of water after the excess lime treatment is to neutralize the excess lime and to convert bicarbonate ions to carbonate.

(20) A filter sand of coarse size retains large quantities of particulate matter but allows the passage of fine particles.

College of Engineering **First Semester**

Civil Engineering Department

First Mid-term Exam

Part Two (aid sheet is provided) Time allowed: One hour

Student Name: ……..

Student Number: …….

Question One (14 %)

(1) Find the weight of sodium-bicarbonate, Na HC03) necessary to make 0.5 M solution; find also the tonality of the solution.

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(2) A wastewater is analyzed for BOD. 10 m L of the wastewater with a dissolved oxygen concentration of 1 mg/L, are mixed with 290 mL of dilution water containing 8 mg/L of dissolved oxygen. After incubation for 5 days at 20 °C, the dissolved oxygen content of the mixture is 5.2 mg/L. Calculate:

(a) The BOD5 of the wastewater.

(b) The ultimate BOD if the rate constant-k (base 10) = 0.14 per day.

(c) The amount of oxygen (kg/day) that is required to the satisfy the BOD demand of 70,000 of this waste, assuming that 1 kg of oxygen is to be applied per kg of ultimate BOD.

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Question One (14 %)

According to the jar tests, a dose of 46 mg/L of alum is needed to reduce the turbidity of 42,000 m^3/day of river water from 50 NTU to about 3 NTU. Find the followings:

(a) How much alkalinity is consumed due to the addition of alum (mg/L as $CaCO_3$)?

(b) What changes take place in the ionic character of the water due to alum addition?

(c) How much mg/L of Al $(OH)_3$ produced?

(d) What is the total sludge produced (g/m^3 of water)?

(e) What is the total volume of sludge produced (m^3 sludge/day) if the solids concentration in sludge = 0.15%?

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Question Three (18%)

The following hypothetical combinations define the ionic character of groundwater:

$Ca(HCO_3)_2$	=	3.meq/L		Na_2S0_4	= 0.2 meq/L
$Mg(HC0_3)_2$	=	0.4 meq/L		NaCl	= 0.6 meq/L
$Mg\ SO_4$	=	0.8 meq/L			

(a) Draw the meq/L bar graph.

(b) Determine the alkalinity and total hardness (mg/L as $CaCO_3$)

(c) Calculate the softening chemicals (mg/L) required if the CO_2 content is 0.5 meq/L.

(d) Calculate the residue produced from the softening process (g/m^3).

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Question Four (14%)

(1) The membrane-filter technique was used to test polluted water for total coliform. 100-mL, 50- mL, 20 mL, 10-mL, and 5-mL portions were examined and the coliform counts were; TNTC, 127, 82, 21, and 0 respectively. Calculate the coliform density for this water (#/100 mL).

Note- TNTC = Too Numerous To Count.

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(2) Determine the diameters of two circular settling tanks, and side water? depth/to settle 15,000 m^3/day of water based on a maximum overflow rate of 16 nr/m .day and detention time of 4.0 h.

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Civil Engineering Department

Second Mid-term Exam

Time allowed: One hour

Student Name: ……..

Student Number: …….

Question One (20 %)

A small town produces 20,000 m^3/day of wastewater on the average. The peak flow is 1.75 times the average.

(a) Design a grit-removal system consisting of two identical chambers 2.0 m deep to process the peak flow. The flow-through velocity is to be controlled at 0.2 m/s by a down stream proportioning weir, and the settling velocity is to be maintained at 0.1 m/s. Determine also the design detention time.

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(b) Design a primary clarification system with at east two tanks. 2.0- m deep provided that the overflow rate should not exceed 70 m^3/m^2.day at the peak flow and the detention time should be at least 1.0 hour.

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Question Two (20%)

A single-stage trickling filter plant is proposed for treating a municipal wastewater flow of 4000 m^3/d with an average BOD of 300 mg/L. Assuming 35% BOD removal in the primary settling tanks calculate the size required for two 3-m deep filters operating in parallel with a BOD loading of 500 g/m^3. d.

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Question Three (20%)

- Determine the activated-sludge aeration volume required to treat 12,000 m3/day with a

BOD5 of 110 mg/L based on the criteria of a maximum BOD loading: of 600 g/m3.day and a minimum aeration period of 3 hours.

- If the operating F/M ratio of)0.25Jg BOD/day per g MLSS is to be maintained in the aeration tank, calculate the suspended solids concentration of the mixed liquor (MLSS),
- What would be the solids concentration in the return sludge if the return flow is 3000 m /day?
- Calculate also the sludge age if the wastage from the return line is 40 m^3/day

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Question Four (20%)

Estimate the mass (kg/day) and .volume (m3/day) of the waste activated sludge from an activated sludge process treating 15,000 m3/day of wastewater with a settled BOD< of 130 mg/L operating at a F/M ratio of 0.24 g BODs per day per g MLSS. The suspended solids in the waste sludge withdrawn from the [return sludge pipe are 9000 mg/L.

If the waste sludge is thickened to 3% what is the volume of the thickened sludge?

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Question Five (20%)

A completely mixed aerated lagoon is being considered for pre-treatment of strong industrial wastewater with K = 0.7 per day at 20 °C using a detention time of 5 days. What is the BOD reduction 20 °C (i.e. removal efficiency)?

If the wastewater temperature is 10°C, compute the detention time required to achieve the same degree of treatment.

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Civil Engineering Department

Second Mid-term Exam

Time allowed: One hour

Student Name: ……..

Student Number: …….

Question One (30 %)

The curve shown below is the results of chlorine demand test oil a raw drinking water at 20 °C and 10-minutes contact time. Determine the following:

(1) The breakpoint chlorine dosage,

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(2) The free residual at a chlorine dosage of 0.9 mg/L,

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(3) The chlorine demand at a dosage of 1 .0 mg/L.

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Question Two (70%)

A trickling-filter plant is proposed for treating domestic wastewater from a small town with population of about 80,000 capita. The expected average and peak flows are $160^{n}JLm^{3}$/day and 25000 m^3/day, respectively. The SS and BOD_5 of the wastewater at the average flow are 400 mg/L and 220 mg/L, respectively.

(A, 20%) Design a grit-removal system such that a chamber is 1.5 m deep, the flow-through velocity is to be controlled at 0.1 m/s, and the settling velocity of grits is about 0.8 m/s. Find also the design detention time.

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(B, 20%) Design a primary clarification system provided that the overflow rate should not exceed 60 m^3/m^2.day and the detention time should be at least 1.0 hour at the peak flow, and a tank .depth of 2.0 meter. Assume the (tanks) are circular in shape.

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(C, 10%) What volume of the primary sludge would be produced daily if the SS of the primary influent is 250/rfig/L, the SS removal efficiency of the' primaries is 40%, and the solids concentration of the primary sludge is 3%.

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(D, 20%) Design a trickling-filter system of random-plastic media. Use a design BOD volumetric loading of 2.0 kg/m^3 and a hydraulic loading between 50-70 m^3/m^2 .day with a

media depth of 4-6 meter. Assume that the BOD removal in the previous treatment processes is 35%.

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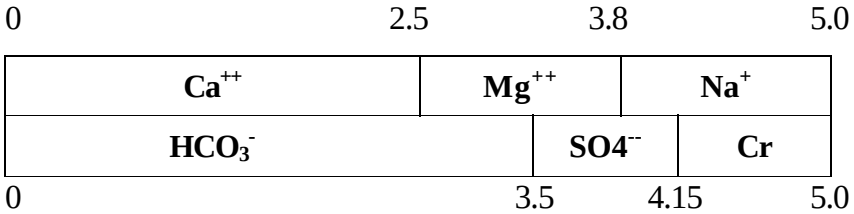
Question Two (70%)

The meq/L bar graph of well water is shown below. Determine:

(a) Total hardness and alkalinity in mg/L as CaCO3.

(b) The softening chemicals (mg/L) required to remove the carbonate hardness.

(c) The final hardness of the treated water.



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Question Four (10%)

Determine the diameters of two circular settling tanks, not over 3.0 m deep, to settle 6500 m^3/day of water provided that the overflow rate should not exceed -30 m^3/m^2.day and the detention time should be at least 2.0 hours.

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Question Five (8%)

Multiple-tube fermentation analyses of well water gave the following results. Determine the total coliform and fecal coliform densities (MPN) and their ranges at the 95% confidence level.

Sample portion (mL)	Number of positive tubes out of five	
	total coliform test	fecal coliform test
10	5	2
1	5	1
0.1	2	0
0.01	1	0
0.001	0	0

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