



UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET

COURSE CODE	: BCE 4043	6/1
COURSE	: WASTE WATER ENGINEERING	
SEMESTER/SESSION	: 1- 2024/2025	
DURATION	: 3 HOURS	

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 7 PRINTED PAGES INCLUDING COVER PAGE

WASTEWATER ENGINEERING (BCE 40403)

QUESTION 1

- a) Describe the processes needed to supply a modern city with clean drinking water from well to river. Describe also the processes needed to treat water after use. (Clarify your answer with sketches if needed) (10 marks)
- b) The results shown in **Table (1)** were obtained for a wastewater sample taken at the headworks to a wastewater-treatment plant. All of the tests were performed using a sample size of 50 ml.

Table (1)

Item	Weight, g
Tare mass of evaporating dish	43.5433
Mass of evaporating dish + residue after evaporation at 105°C.	43.5794
Mass of evaporating dish + residue after ignition at 550°C.	43.5625
Tare mass of Whatman paper filter	1.5433
Mass of Whatman paper filter + residue after evaporation at 105°C.	1.5554
Mass of Whatman paper filter + residue after ignition at 550°C.	1.5476

Determine the followings:

- i. Concentration of total solids
- ii. Total volatile solids
- iii. Total suspended solids
- iv. Volatile suspended solids
- v. Dissolved solids.

(3 marks)

(3 marks)

(3 marks)

(3 marks)

(3 marks)

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QUESTION 2

- a) If the Dissolved Oxygen (O_2) in H_2O is 100g/L, determine the mole fraction of dissolved oxygen (4 marks)
- b) Differentiate the characteristic between soft water and hard water. (4 marks)
- c) The results of a water analysis are shown in **Table (2)** below:

Table (2)

Cations	Mg/L	Anions	Mg/L
Ca	58.0	HCO_3	342
Mg	32.8	SO_4	72
Na	46.0	Cl	48
K	35.0	-	-

- i. Convert miligrams per liter concentration to miliequivalents per liter (4 marks)
- ii. Illustrate the miliequivalence per liter bar graph (4 marks)
- iii. List hypothetical combinations (4 marks)
- iv. Calculate hardness as mg/L of $CaCO_3$ for this water analysis (5 marks)

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QUESTION 3

- a) The BOD_5 of a wastewater is determined to be 150 mg/L at 20°C. The k value is known to be 0.23 per day. Find the BOD_8 if the test were run at 15°C. (6 marks)
- b) Ten (10) identical test bottles were prepared, each with 50 ml of treated wastewater and 250 ml of dilution water. After setup, three (3) bottles were titrated to establish an initial dissolved oxygen (DO) of 9.0 mg/L. The remaining seven (7) bottles were incubated, and DO measurements were taken over time as follows:
- 1.2 days, DO = 8.0 mg/L
 - 3.2 days, DO = 7.0 mg/L
 - 4.2 days, DO = 6.8 mg/L
 - 5.2 days, DO = 6.5 mg/L
 - 7.2 days, DO = 5.3 mg/L
 - 10.2 days, DO = 4.0 mg/L
- i. Determine the 5 -day biochemical oxygen demand (BOD_5) (10 marks)
- ii. Illustrate the BOD-time curve and graph for determination of the k -rate. (9 marks)

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QUESTION 4

a) Explain the followings:

i. Multiple-tube fermentation technique (5 marks)

ii. Most Probable Number (MPN) (4 marks)

b) A sample of wastewater was collected every 3 hours from an industrial treatment plant over a 24-hour period, as shown in **Table 3**.**Table 3**

Time (h)	BOD (mg/L)	TSS (mg/L)	Flowrate (m ³ /d)
0000	100	130	7000
0300	120	140	8500
0600	150	160	9300
0900	190	200	11000
1200	210	215	12500
1500	195	205	11800
1800	185	190	10000
2100	170	180	9500
2400	150	170	8700

Calculate the following:

i. Weighted total BOD in g/m³ (8 marks)ii. Weighted total TTS in g/m³ (8 marks)

-----End of question-----

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APPENDIX I

THE PERIODIC TABLE

THE PERIODIC TABLE																																			
1 IA		2 IIA												13 IIIA		14 IVA		15 VA		16 VIA		17 VIIA		18 VIIIA											
H 1 1.008 Hydrogen		Li 3 6.94 Lithium		Be 4 9.01 Beryllium												B 5 10.81 Boron		C 6 12.01 Carbon		N 7 14.01 Nitrogen		O 8 16.00 Oxygen		F 9 19.00 Fluorine		Ne 10 20.18 Neon									
Na 11 22.99 Sodium		Mg 12 24.31 Magnesium												Al 13 26.98 Aluminum		Si 14 28.09 Silicon		P 15 30.97 Phosphorus		S 16 32.07 Sulfur		Cl 17 35.45 Chlorine		Ar 18 39.95 Argon											
K 19 39.10 Potassium		Ca 20 40.08 Calcium		Sc 21 44.96 Scandium		Ti 22 47.88 Titanium		V 23 50.94 Vanadium		Cr 24 52.00 Chromium		Mn 25 54.94 Manganese		Fe 26 55.85 Iron		Co 27 58.93 Cobalt		Ni 28 58.69 Nickel		Cu 29 63.55 Copper		Zn 30 65.39 Zinc		Ga 31 69.72 Gallium		Ge 32 72.61 Germanium		As 33 74.92 Arsenic		Se 34 78.96 Selenium		Br 35 79.90 Bromine		Kr 36 83.80 Krypton	
Rb 37 85.47 Rubidium		Sr 38 87.62 Strontium		Y 39 88.91 Yttrium		Zr 40 91.22 Zirconium		Nb 41 92.91 Niobium		Mo 42 95.94 Molybdenum		Tc 43 (97.9) Technetium		Ru 44 101.07 Ruthenium		Rh 45 102.91 Rhodium		Pd 46 106.42 Palladium		Ag 47 107.87 Silver		Cd 48 112.41 Cadmium		In 49 114.82 Indium		Sn 50 118.71 Tin		Sb 51 121.76 Antimony		Te 52 127.60 Tellurium		I 53 126.90 Iodine		Xe 54 131.29 Xenon	
Cs 55 132.91 Cesium		Ba 56 137.33 Barium		La 57 138.91 Lanthanum		Hf 72 178.49 Hafnium		Ta 73 180.95 Tantalum		W 74 183.85 Tungsten		Re 75 186.21 Rhenium		Os 76 190.2 Osmium		Ir 77 192.22 Iridium		Pt 78 195.08 Platinum		Au 79 196.97 Gold		Hg 80 200.59 Mercury		Tl 81 204.38 Thallium		Pb 82 207.2 Lead		Bi 83 208.98 Bismuth		Po 84 (209) Polonium		At 85 (210) Astatine		Rn 86 (222) Radon	
Fr 87 223.02 Francium		Ra 88 226.03 Radium		Ac 89 227.03 Actinium		Rf (261) Rutherfordium		Db (262) Dubnium		Sg (263) Seaborgium		Bh (264) Bohrium		Hs (265) Hassium		Mt (266) Meitnerium		Ni 110 (267) Nihonium		Un 111 (268) Ununbium		Un 112 (269) Ununbium		Un 114 (270) Ununbium		Un 115 (271) Ununpentium		Un 116 (272) Ununhexium		Un 118 (273) Ununseptium		Un 119 (274) Ununseptium		Un 120 (275) Ununseptium	
ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS		ALLOYS	

WASTEWATER ENGINEERING

APPENDIX II

TABLE 3-2 MPN Index and 95 Percent Confidence Limits for Coliform Counts by the Multiple-Tube Fermentation Technique for Various Combinations of Positive and Negative Results When Five 10-ml, Five 1-ml, and Five 0.1-ml Portions Are Used

No. of Tubes Giving Positive Reaction out of			MPN Index per 100 ml	95 Percent Confidence Limits		No. of Tubes Giving Positive Reaction out of			MPN Index per 100 ml	95 Percent Confidence Limits	
5 of 10 ml Each	5 of 1 ml Each	5 of 0.1 ml Each		Low	High	5 of 10 ml Each	5 of 1 ml Each	5 of 0.1 ml Each		Low	High
0	0	0	1.8	—	6.8	4	2	1	26	9.8	70
0	0	1	1.8	0.09	6.8	4	3	0	27	9.9	70
0	1	0	1.8	0.09	6.9	4	3	1	33	10.0	70
0	2	0	3.7	0.70	10	4	4	0	34	14.0	100
1	0	0	2.0	0.10	10	5	0	0	23	6.8	70
1	0	1	4.0	0.70	10	5	0	1	31	10.0	70
1	1	0	4.0	0.71	12	5	0	2	43	14.0	100
1	1	1	6.1	1.8	15	5	1	0	33	10.0	100
1	2	0	6.1	1.8	15	5	1	1	46	14.0	120
						5	1	2	63	22.0	150
2	0	0	4.5	0.79	15						
2	0	1	6.8	1.8	15	5	2	0	49	15.0	150
2	1	0	6.8	1.8	17	5	2	1	70	22.0	170
2	1	1	9.2	3.4	22	5	2	2	94	34	230
2	2	0	9.2	3.4	22	5	3	0	79	22	220
2	3	0	12.0	4.1	26	5	3	1	110	34	250
						5	3	2	140	52	400
3	0	0	7.8	2.1	22						
3	0	1	11.0	3.5	23	5	3	3	170	70	400
3	1	0	11.0	3.5	26	5	4	0	130	36	400
3	1	1	14.0	5.6	36	5	4	1	170	58	400
3	2	0	14.0	5.7	36	5	4	2	220	70	440
3	2	1	17.0	6.8	40	5	4	3	280	100	710
						5	4	4	350	100	710
4	0	0	13.0	4.1	35	5	5	0	240	70	710
4	0	1	17.0	5.9	36	5	5	1	350	100	1100
4	1	0	17.0	6.0	40	5	5	2	540	150	1700
4	1	1	21.0	6.8	42	5	5	3	920	220	2600
4	1	2	26.0	9.8	70	5	5	4	1600	400	4600
4	2	0	22.0	6.8	50	5	5	5	>1600	700	—

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