THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING – THIRD YEAR DEGREE

SECOND SEMESTER   EXAMINATION - 2021

CE 321 – ENVIRONMENTAL ENGINEERING

DATE: **Wednesday, 27 OCTOBER 2021**

ROOM: **SLT**

TIME: **12:50 P.M.**

DURATION: **3 HOURS**

INSTRUCTIONS TO CANDIDATES

1.   Check that there are **8** different pages of this Examination Paper.
2.   You have ten (10) minutes to read this Examination Paper.
3.   This paper contains **30** questions in three (3) Parts.
      Part A   Problem Solving   (35 marks)
      Part B   Short/Long Answer Questions   (35 marks)
      Part C   Multiple Choice Questions   (30 marks)
      Total   **100 MARKS**
4   Write your name, student number and course on the front page of the answer
      booklet.
5.   Answer **ALL** questions. .
6.   **All answers must be written on the ANSWER SHEET provided**. No other written
      material will be accepted.
7.   Mobile phones, notes and notebooks are **NOT** allowed.

_____/100

DO NOT WRITE UNTIL YOU ARE TOLD TO START

PROBLEM SOLVING   (35 MARKS)

Write best answers to the questions on your answer sheet in Black or Blue ink.
Start here

Question 1 (5 Marks)

The BOD_8 of a wastewater is determined to be 600 mg/L at 20° C. The k value at 20° C is known to be 0.23 per day. What would be BOD_9 value if tests were run at 15° C?

Question 2 (9 Marks)

A community produces the following on an annual basis:

Fraction	Tons per year	Percentage(by weight)	Uncompacted bulk density
Mixed house waste	250	80	4.81 (lb/ft3)
Recyclables	25	50	3.81 (lb/ft3)
Commercial wastes	35	10	43.8 (lb/ ft3)
Construction and demolition debris, C & D	110	20	4.45 (lb/ft3)
Leaves and miscellaneous	50	20	18.45(lb/ft3)
Treatment plant sludges	10	5	25.45(lb/ft3)

The recyclables are collected separately and processed at a materials recovery facility. The mixed household waste and commercial waste go to the landfill, as do the leaves and miscellaneous solid wastes. The sludges are dried and applied on land (not into the landfill) and the C & D wastes are used to fill a large ravine.

A. Calculate the recycling efficiency in % (3 marks)

B. Estimate the reduction in disposal efficiency in % (3 marks)

C. Estimate the diversion efficiency in % (3 marks)

Question 3 (6 Marks)

Determine the

a) moisture content and
b) energy value of a typical residential MSW with the average composition shown in the table

Table (1): Typical physical composition of residential municipal solid waste

Component	Percent by weight	
	Range	Typical
Organic		
Food wastes	6 – 18	9.0
Paper	25 – 40	34.0
Cardboard	3 – 10	6.0
Plastics	4 – 10	7.0
Textiles	0 – 4	2.0
Rubber	0 – 2	0.5
Leather	0 – 2	0.5
Yard wastes	5 – 20	18.5
Wood	1 – 4	2.0
Miscellaneous organics	-	-
Inorganic		
Glass	4 – 12	8.0
Tin cans	2 – 8	6.0
Aluminum	0 – 1	0.5
Other metal	1 – 4	3.0
Dirt, ash, etc.	0 - 6	3.0
Total		100

Table (2): Typical values for energy content of residential municipal solid waste

Component	Energy[6], Btu/lb	
	Range	Typical
Organic		
Food wastes	1500 - 3000	2000
Paper	5000 - 8000	7200
Cardboard	6000 - 7500	7000
Plastics	12000 - 16000	14000
Textiles	6500 - 8000	7500
Rubber	9000 - 12000	10000
Leather	6500 - 8500	7500
Yard wastes	1000 – 8000	2800
Wood	7500 - 8500	8000
Miscellaneous organics	-	-
Inorganic		
Glass	50 - 100[7]	60
Tin cans	100 - 500[1]	300
Aluminum	-	-
Other metal	100 - 500[1]	300
Dirt, ash, etc.	1000 – 5000	3000
Municipal solid wastes	4000 – 6000	5000

Question 4(5 Marks)

Ethane (C_2H_6) is burned in a combustion reactor. The gas fed to the reactor contains 5.4% C_2H_6, 20.1% O_2 and 74.5% N_2 (all mol%). If C_2H_6 is burned completely into CO_2 and the reactor is operating at steady-state, reaction involved: $C_2H_6 + 3.5O_2 = 2CO_2 + 3H_2O$. Determine the composition (in mol%) of the product gas exiting the reactor.

Feed gas
100 mol
→ Reactor →
Product gas

5.4% C2H6
20.1% O2
74.5% N2

Moles?
Composition?
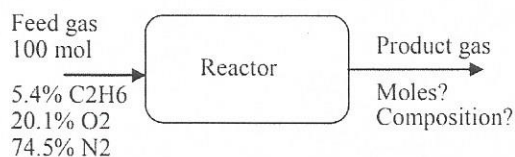
Question 5 (5 Marks)

Find the replacement cost that the Department of Civil Engineering is planning for a replacement of a Compression Testing Machine at the Concrete Laboratory which remaining service life is 3 years, its service life exceeds 20 years (-20) and the capital value on the year of purchase of the machine is PGK 600,000. The planning period is 1 year.

Question 6 (5 Marks)

A fan is carrying an airflow through an incinerator, heat exchanger, ductwork, and stack. The flow rate exiting the heat exchanger is approximately 40,000 acfm.

Determine
   a) The total pressure change (see the pressure drop information in Table 5)

   b) The fan cost and motor cost considering period July 1989 and that of April 1987. The fan price curve (see fig 3) and, consult table 12 and CE fabricated equipment cost indexes.

Table 5
Assumed Pressure Drops Across Various Components

System component	Pressure drop (in. H_2O)
Stack	0.6
Ductwork	0.6
Thermal incinerator	4.1
Heat exchanger	2
Catalytic incinerator	6
Absorber	Variable[a]
Carbon adsorber	6
Condenser	3
Fabric filter	6
Electrostatic precipitator	0.5
Venturi scrubber	ΔP_v

[a]Use Eq. (1) to determine the pressure drop.
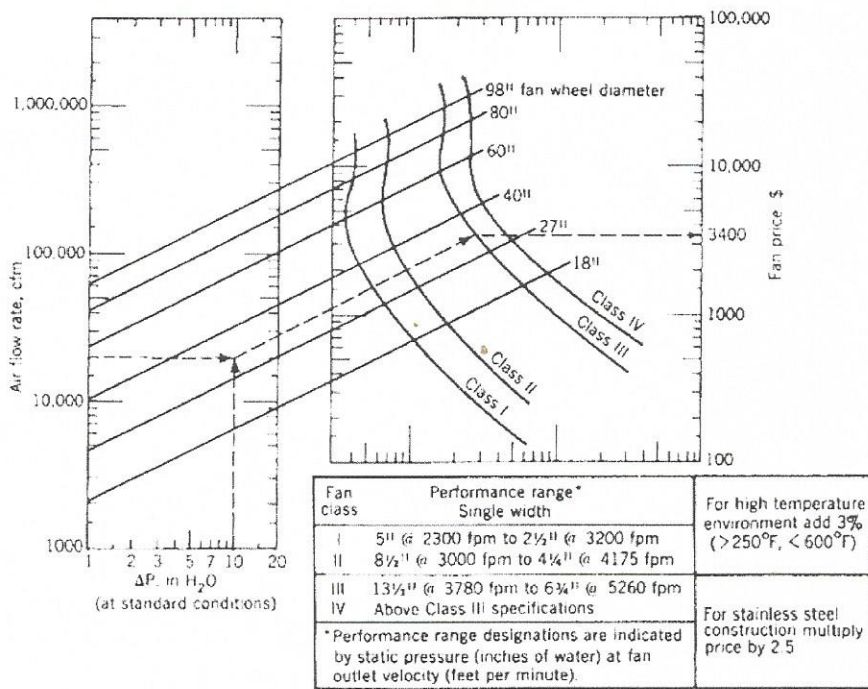
Fig. 3. Fan price. (From ref. 30.)

Table 12
Chemical Engineering Equipment Index

Date	Index	Date	Index	Date	Index
Feb. 1990	389.0	May 1988	369.5	Aug. 1986	334.6
Jan. 1990	388.8	Apr. 1988	369.4	July 1986	334.6
Dec. 1989	390.9	Mar. 1988	364.0	June 1986	333.4
Nov. 1989	391.8	Feb. 1988	363.7	May 1986	334.2
Oct. 1989	392.6	Jan. 1988	362.8	Apr. 1986	334.4
Sept. 1989	392.1	Dec. 1987	357.2	Mar. 1986	336.9
Aug. 1989	392.4	Nov. 1987	353.8	Feb. 1986	338.1
July 1989	392.8	Oct. 1987	352.2	Jan. 1986	345.3
June 1989	392.4	Sept. 1987	343.8	Dec. 1985	348.1
May 1989	391.9	Aug. 1987	344.7	Nov. 1985	347.5
Apr. 1989	391.0	July 1987	343.9	Oct. 1985	347.5
Mar. 1989	390.7	June 1987	340.4	Sept. 1985	347.2
Feb. 1989	387.7	May 1987	340.0	Aug. 1985	346.7
Jan. 1989	386.0	Apr. 1987	338.3	July 1985	347.2
Dec. 1988	383.2	Mar. 1987	337.9	June 1985	347.0
Nov. 1988	380.7	Feb. 1987	336.9	May 1985	347.6
Oct. 1988	379.6	Jan. 1987	336.0	Apr. 1985	347.6
Sept. 1988	379.5	Dec. 1986	335.7	Mar. 1985	346.9
Aug. 1988	376.3	Nov. 1986	335.6	Feb. 1985	346.8
July 1988	374.2	Oct. 1986	335.8	Jan. 1985	346.5
June 1988	371.6	Sept. 1986	336.6	Dec. 1984	346.0

^{a}(2, 30)

Note: CE Equipment Index = 437.4 in April 2000; CE Equipment Index = 273.7 in December 1979; CE Equipment Index = 226.2 in December 1977.

Source: refs. 2 and 36.

End of Part A, proceed to Part B

PART B.   SHORT/LONG ANSWER QUESTIONS   (35 MARKS)

Question 7 (2 Marks)
What is the purpose of material and energy balance?

Question 8 (5 Marks)
What are the benefits of MSW properties?

Question 9 (6 Marks)
What are the pollutants of concern that may be found in the combustion products, prior to the air pollution control device (APCD) and/or in the stack emissions, along with the controls used to reduce their discharge to the atmosphere.

Question 10 (5 Marks)
List at least 5 devices, used as components in complete air emission control systems, for control of emissions.

Question 11 (2 Marks)
Speed of sound in air is _____ m/s

Question 12 (2 Marks)
92dB + 92dB + 45dB + 45dB is _____

Question 13 (3 Marks)
Find the single payment present worth factor (ssppwf = $1/(1+1)^n$), if the interest rate is 12% for 10 years.

Question 14 (2 Marks)
What is the sound wave arrival at time equation?

Question 15 (4 Marks)
Name the four hazardous waste description categories

Question 16 (4 Marks)
What must be done to manage hazardous waste?

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End of Part B, proceed to Part C

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PART C.   MULTIPLE CHOICE QUESTIONS   (30 MARKS)

Write best answers (LETTER/S AND/OR TEXTS ASSOCIATED TO IT) to the questions on your answer sheet.

Start here

Question 17 (3 marks)
In solids analysis, the following measurements were obtained:
  - sample size of 50 mL
  - after filtration/evaporation: 122 mg filter cake, 2.5 mg solids in filtrate
  - after high temperature oxidations: 2.0 mg filter cake

What is TS?
A. 0.24 mg/mL   B. 0.29 mg/mL   C. 0.20 mg mg/mL   d. NIL

Question 18 (3 marks)
In solids analysis, the following measurements were obtained:
  - sample size of 50 mL
  - after filtration/evaporation: 122 mg filter cake, 2.5 mg solids in filtrate
  - after high temperature oxidations: 2.0 mg filter cake

What is TSS?
A. 0.24 mg/mL   B. 0.29 mg/mL   C. 0.20 mg mg/mL   d. NIL

Question 19 (2 marks)
Pure Water has a PH of
A. 5
B. 6
C. 7
D. Not in the List (NIL)

Question 20 (2 marks)
The equation for solving Total Dissolves Solid (TDS) in mg per Liter is

A. $\dfrac{Beaker\ Post\ weight\ (mg) + Beaker\ pre\ weight\ (mg) * 1000}{Sample\ Volume\ (mL)}$

B. $\dfrac{Beaker\ Post\ weight\ (mg) - Beaker\ pre\ weight\ (mg) * 1000}{Sample\ Volume\ (mL)}$

C. $\dfrac{Filter\ Post\ weight\ (mg) - Filter\ pre\ weight\ (mg) * 1000}{Sample\ Volume\ (mL)}$

D. NIL

Question 21 (2 marks)
The equation for solving Total Suspended Solids (TSS) in mg per Liter is

A. $\dfrac{Beaker\ Post\ weight\ (mg) + Beaker\ pre\ weight\ (mg) * 1000}{Sample\ Volume\ (mL)}$

B. $\dfrac{Beaker\ Post\ weight\ (mg) - Beaker\ pre\ weight\ (mg) * 1000}{Sample\ Volume\ (mL)}$

C. $\dfrac{Filter\ Post\ weight\ (mg) - Filter\ pre\ weight\ (mg) * 1000}{Sample\ Volume\ (mL)}$

D. NIL

Question 22 (2 marks)
Is a type of pollutant consisting of solids, temperature, color, turbidity, salinity and odor
A. Physical
B. Chemical
C. Biological
D. NIL

Question 23 (2 marks)
Is a type of pollutant consisting of organic, inorganic and gaseous
A. Physical
B. Chemical
C. Biological
D. NIL

Question 24 (2 marks)

Unpolluted rainwater actually has a pH of about 5.6

A. TRUE

B. FALSE

Question 25 (2 marks)

Conductivity indicates chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron, and aluminum ions.

A. TRUE

B. FALSE

Question 26 (2 marks)

Turbidity measures capacity to neutralize acids from the rainfall or wastewater

A. TRUE

B. FALSE

Question 27 (2 marks)

Alkalinity is a measure of water clarity

A. TRUE

B. FALSE

Question 28 (2 marks)

The human ear can detect sounds in frequency range of about 20 to 20000 Hz

A. TRUE

B. FALSE

Question 29 (2 marks)

80 – 130 dBA TTS hearing loss is noticeable

A. TRUE

B. FALSE

Question 30 (2 marks)

Capture rate has the greatest importance in the measure of performance to measure the success of a separation and collection program.

A. TRUE

B. FALSE

ALL THE BEST!

END OF CE 321.2021 FINAL EXAM - ENVIRONMENTAL ENGINEERING