UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE FZE

BENG (HONS) CIVIL ENGINEERING

SEMESTER TWO EXAMINATION 2023/2024

SOIL MECHANICS AND HYDRAULICS

MODULE NO. CIE4020

Date: 9th May 2024 **Time: 10:00am-12:00**

INSTRUCTIONS TO CANDIDATES:

There are SIX questions on this paper.

Answer ANY FIVE questions.

Answer SECTION A and SECTION B in separate answer books.

Marks for parts of questions are shown in brackets.

Formula sheet/supplementary information is provided at the end of each section and additional data will be provided at the time of examination.

Attach Page Number 9 along with the answer script.

All working must be shown. A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

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SECTION A- SOIL MECHANICS

Question 1

a) Sketch and explain a "soil model" diagram clearly showing the solids, water and air components annotated with conventional symbols to allow the development of 'soil property' equations.

(4 Marks)

b) A sample of saturated clay has a mass of 2000g in its natural state and 1525g after drying. The specific gravity of soil, Gs =2.7, determine the values of

i) Water content

(3 Marks)

ii) Void ratio

(3 Marks)

iii) Porosity

(2 Marks)

c) A soil sample had a mass of 220g and a volume of 56.4 cm^3 in its natural state. Its dry mass was 150.50g. If the Specific gravity of the soil is 2.7, determine

i) Soil density

(4 Marks)

ii) Dry unit weight

(4 Marks)

Total 20 marks

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Question 2

a) A clay sample has a plasticity index of 26, liquidity index of 0.31 and plastic limit of 31. Calculate

i) Water content of the clay

(4 Marks)

ii) Degree of saturation

(4 Marks)

iii) Bulk unit weight of the clay if its specific gravity is 2.7 and void ratio is 0.98

(4 Marks)

b) What is the importance of soil compaction in construction? What are the laboratory testing procedures for soil compaction?

(8 Marks)

Total 20 marks

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Question 3

a) Plastic Limit experiment was done on a cohesive soil and the following results were obtained as shown in **Table Q3(a)**. Determine the Plastic limit of the given soil.

Table Q3(a): PLASTIC LIMIT TEST

Test no.	1	2	3
Mass of container(g)	15	15.1	14.8
Mass of container+wet soil(g)	31	32.5	30.4
Mass of container+dry soil(g)	28	26	27.2

(8 marks)

b) A British standard 2.5kg "light" compaction test on a soil sample (G_s = 2.71) gave the following results:

Table Q3(b): COMPACTION TEST RESULT

Moisture Content (%)	**Bulk Density (kg/m^3)**
12	1776
14	1986
16	2176
18	2221
20	2196
22	2156

Using the data provided in the above table, plot the compaction curve on **Figure Q3 (b)** on **Page 9** to obtain the maximum dry density and the optimum water content. (12 marks)

Total 20 Marks

END OF SECTION A

PLEASE TURN THE PAGE FOR SECTION B

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SECTION B- HYDRAULICS

Question 4

a) Water pressure at a pipeline junction measures 450 kPa. What is the corresponding pressure head?

(5 marks)

b) Water flows from a storage tank along a 275mm diameter pipe, 60m long at a rate of 0.25m^3/s. The pipe includes a 90° bend (k_L = 0.7) and a partially shut valve (k_L = 6). If the pipe entrance is sharp and the flow discharges to the atmosphere at the end of the pipe,

i) Calculate the necessary difference in level between the tank water level and the outlet. Take the pipe friction factor, λ = 0.04.

(12 marks)

ii) Sketch the flow lines and zones of turbulence for the Partially shut valve

(3 marks)

Total 20 marks

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Question 5

a) Water enters a pump through a 150 mm diameter intake pipe and leaves the pump through a 200 mm diameter discharge pipe. If the average velocity in the intake pipeline is 1 m/s. calculate the average velocity in the discharge pipeline. What is the flow rate through the pump?

(8 marks)

b) A galvanised iron pipe from a water main, with friction factor λ =0.02, is required to deliver 200 l/s during a fire. If the length of the service pipe is 35 m and the allowable head loss in the pipe is 50 m, calculate the pipe diameter to be used.

(6 marks)

c) Explain the distinction between laminar and turbulent flow in a pipeline with suitable equations for the classification.

(6 marks)

Total 20 marks

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Question 6

a) A rectangular channel 2m wide carries water with a discharge of 10 m3/s. A rectangular weir Figure Q6 (a) is to be installed across the canal to raise the water level 4m above the channel floor. Calculate the required height of the weir 'P' if the weir is suppressed. Assume C_d = 0.6

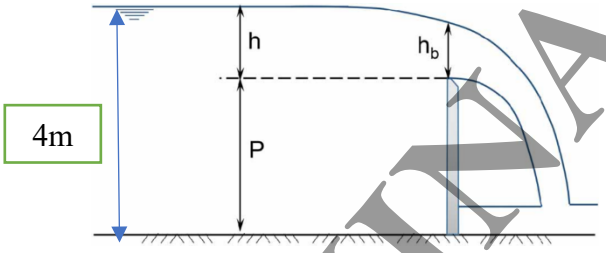

Figure Q6 (a)

(8 marks)

b) A concrete lined trapezoidal channel has a water depth 'y' of 2.0 m. The base width 'B' of the channel is 4.0 m and the side slope (V: H =1:1.5). Manning's roughness coefficient 'n' is 0.013 and the channel bed slope 'S'=0.002. Calculate the Discharge passing through the cross-section of the channel using Manning's equation.

(12 marks)

Total 20 marks

END OF SECTION B

END OF QUESTIONS

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Formula Sheet for Section A

$$V_w = \frac{W_w}{\gamma_w}$$

$$V_s = \frac{W_s}{G_s \gamma_w}$$

$$Total\ Volume\ V = V_a + V_s + V_w$$

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This sheet should be attached along with the answer Script

CANDIDATE NUMBER:

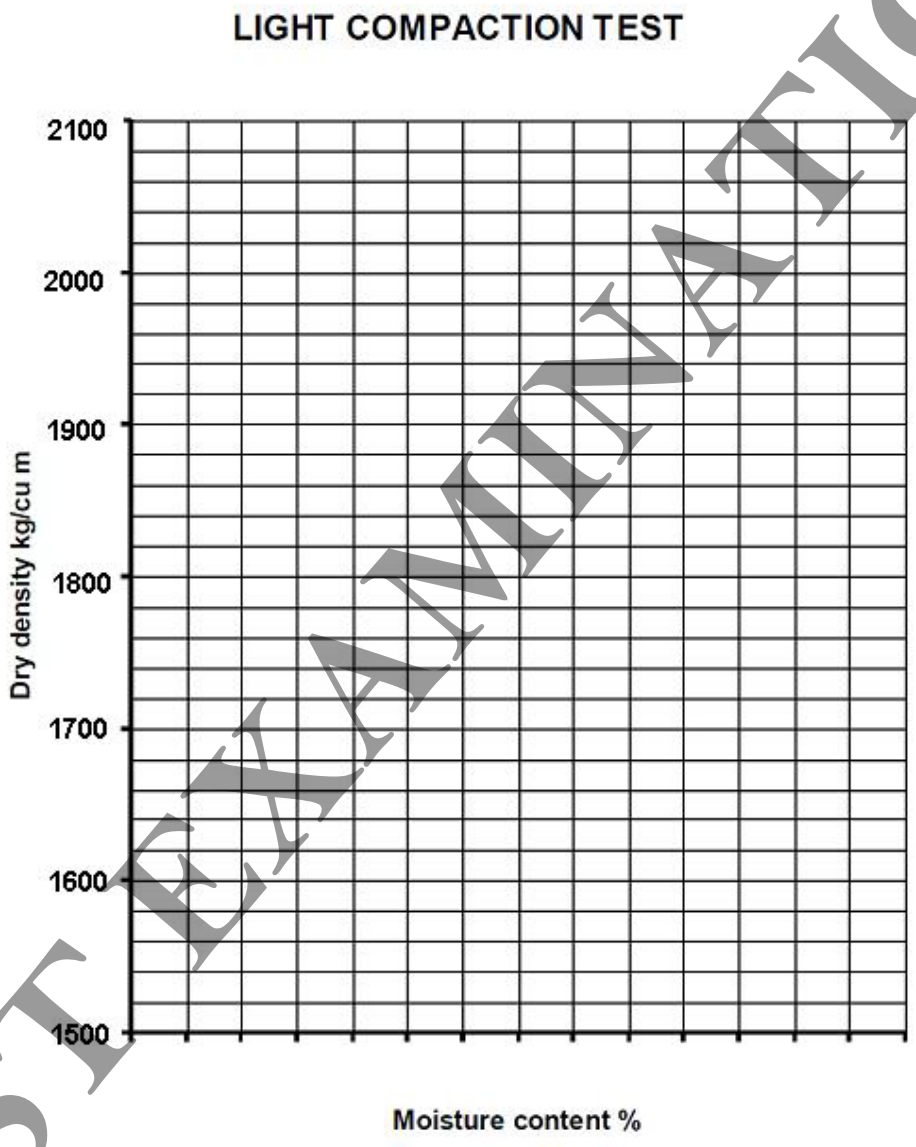

Figure Q3 (b)

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Formula sheet for Section B

$$P = \rho g h$$

$$Q = AV$$

$$Q = \frac{A}{n}.R^{2/3}.S_o^{1/2}$$

$$R = \frac{A}{P}$$

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + hf + hL$$

$h_f = S_0 \times L$

$$h_f = \frac{\lambda L v^2}{2gd} = \frac{\lambda L Q^2}{12.1 d^5}$$

$$H_L = K_L . \frac{v^2}{2g}$$

$K_{L\ entry\ to\ pipe} = 0.5$; $K_{L\ exit\ from\ a\ pipe} = 1$

$$Q = \frac{2}{3} C_d\, L \sqrt{2g} H^{3/2}$$

END OF FORMULA SHEET