Second Semester Examination
2021/2022 Academic Session

July/August 2022

EAH316 – Hydraulic Structure

Duration : 1 hour

Please ensure that this examination paper consists of **SEVEN (7)** pages of printed material before you begin the examination.

Instructions: This paper contains **THREE (3)** questions. Answer **ANY TWO (2)** questions.

All questions **MUST BE** answered on a new page.

1. (a) Briefly discuss **FIVE (5)** factors which affect the magnitude of flow for hydraulic outlet structure.

[10 marks]

(b) Sluice gate is used in a channel to transport an irrigation water. The depth of flow upstream of sluice gate is 2.5 m (h_1) with normal flow condition. Assume the flow rate under sluice gate is uniform until hydraulic jump downstream. The detail of the rectangular irrigation channel is as follows:

Longitudinal slope (S_o) = 1/1000
Contraction coefficient (C_c) = 0.62
Sluice gate opening (a) = 1.5 m
Manning (n) = 0.01
Width (W) =3 m

Compute the difference of total energy (ΔE) between upstream and downstream of sluice gate. Assume there is energy loss in the computation of flow rate under the sluice gate.

The equation of flow rate under the sluice gate with energy loss is given as:

$$q = C_c h_1 a \sqrt{\frac{2g}{(h_1 + h_2)}}$$

[10 marks]

2. (a) An overfall spillway was designed to allow a head of 3.0 m. The length of the spillway is 225 m.

i) Determine the discharge of the spillway when the head is 0.25 m and 1.45 m.
(Note : Maximum head with no cavitation accurs at H_{max}=1.65 $H_{d)}$

ii) Assuming that the dam freeboard is high enough and the spillway was constructed to prevent cavitation, determine the maximum discharge (H_{max}) that can be passed over the spillway.

[15 marks]

(b) With the aid of diagrams, show any **FOUR (4)** principal defect mechanisms and failure modes identifiable to embankment dams.

[5 marks]

3. (a) A centrifugal pump delivers 25 L/s of water against a head of 10 m and running at 1300 rpm requires 10 kW of power.

i) Determine the discharge, head of the pump, and power required if the pump maximum run is at 1500 rpm.

ii) Explain if the pump is suitable to supply water to 10 storey buildings.

[8 marks]

(b) A pump station is used to fill a tank on a hill above a lake as shown in **Figure 1**, the flow rate is 10.8 L/s at a temperature of 29^{o}C. The pump is 4 m above the lake and the tank water level is 120 m above the pump. The suction and discharge lines are 11 cm diameter steel pipes. The equivalent length of the inlet line between the lake and the pump is 120 m while the total equivalent length between the lake and the tank is 2500 m. The overall efficiency of the pump and motor is 85%. Determine:

i). The required power of the motor in kW.

ii) The NPSH for this application.

(Given: ε = 0.009 m for steel pipe, υ for water at 29^{o}C = 8.03 x 10^{-5} m^2/s, P atm = 101 KN/m^2, P vapor at 29^{o}C = 4 KN/m^2)

[12 Marks]

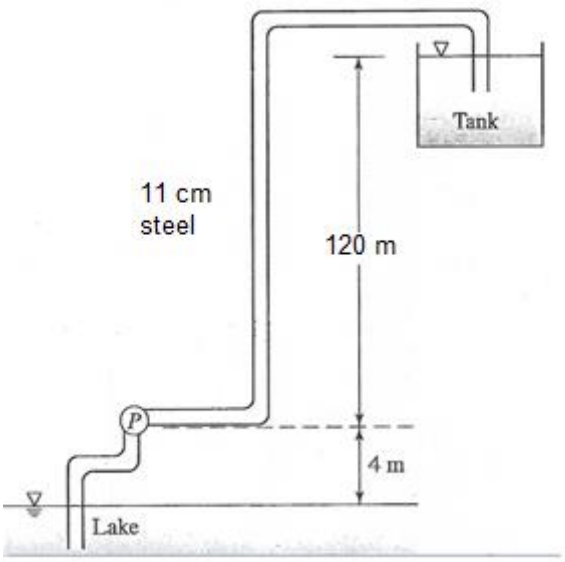

Figure 1

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APPENDIX

$$\frac{y_2}{y_1} = \frac{1}{2}\sqrt{1 - 8Fr^2} - 1$$

$$\Delta E = \frac{(y_2 - y_1)^3}{4y_1y_2}$$

$$Q = \frac{2}{3}C_d\sqrt{2g}bH^{\frac{3}{2}}$$

Coefficient of discharge for spillway,

	C_d
$H_d = H_{max}$	0.745
$H_d > H_{max}$	$0.578 > C_d > 0.745$
$H_{max} \approx 1.65H_d$	0.81

…7/-

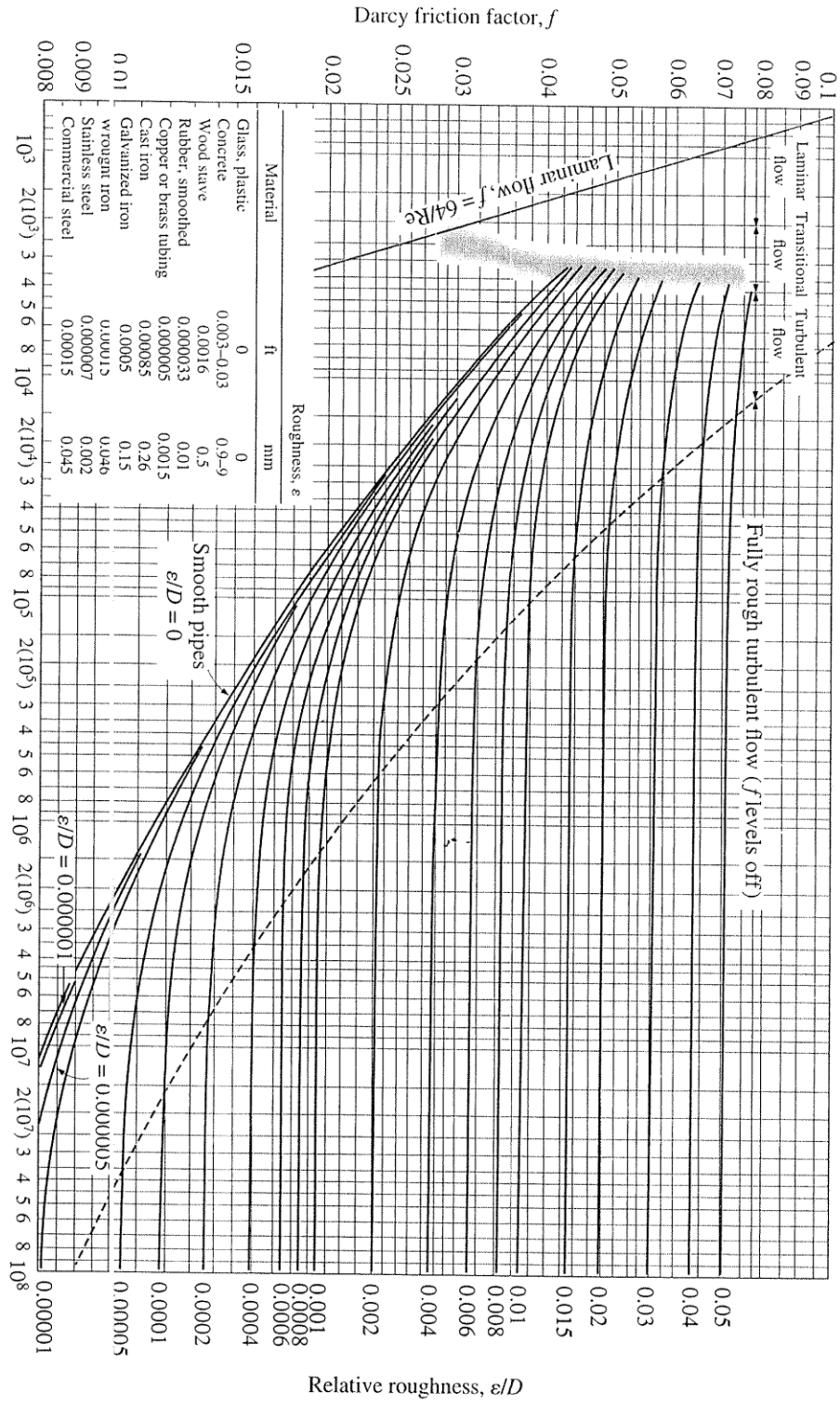

FIGURE A–12

The Moody chart for the friction factor for fully developed flow in circular pipes for use in the head loss relation $h_L = f\frac{L}{D}\frac{V^2}{2g}$. Friction factors in the turbulent flow are evaluated from the Colebrook equation $\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}\sqrt{f}}\right)$.

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