Dr Pooja Thakur 2/12/2022 (73)

(M)

Roll No. .....

National Institute of Technology Hamirpur

B. Tech. (Chemical Engineering) – 3rd Semester

End Semester Examination 2022-23

CH-211 Fluid Mechanics

Duration: 3 hours **Max. Marks: 50**

- *Make suitable assumptions if necessary, by clearly mentioning them.*
- *Marks will be deducted for omitting steps.*
- *Write roll number, subject code and subject name at the top of answer sheet.*
- *Do signature with date at the bottom of each page.*

1) Water at 10 °C flows from a large reservoir to a smaller one through a 5 cm diameter cast iron piping system as shown in Fig. 1. Determine the elevation z_1 for a flow rate of 6 L/s. Use standard equations to calculate the friction factor however the roughness of the cast iron pipe is $\varepsilon = 0.00026$ m. At 10 °C, the density and dynamic viscosity of the water is $\rho = 999.7$ kg/m^3 and $\mu = 1.307 \times 10^{-3}$ kg/(m .s). **(10 Marks)**

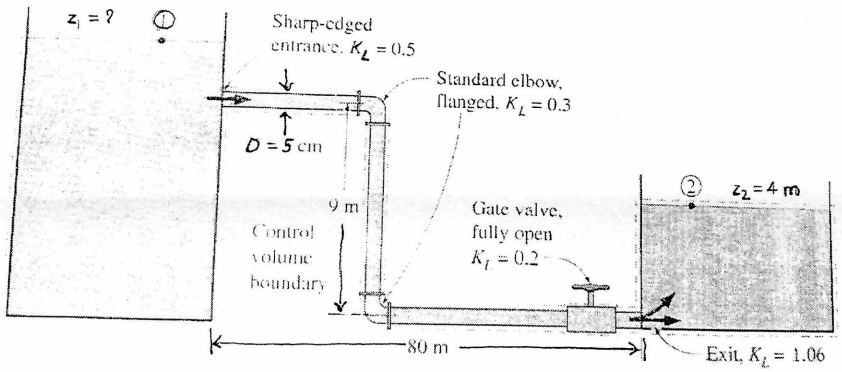

Fig. 1: The piping system

2) Consider the steady, incompressible, laminar flow of a Newtonian fluid in the narrow gap between two infinite parallel plates in Fig. 2. The top plate is moving at speed V, and the bottom plate is stationary. The distance between these two plates is h, and gravity acts in the negative z-direction (into the page). There is no applied pressure other than hydrostatic pressure due to gravity. This flow is called Couette flow. State all assumption and calculate the velocity and pressure fields and estimate the shear force per unit area acting on the bottom plate. **(15 Marks)**

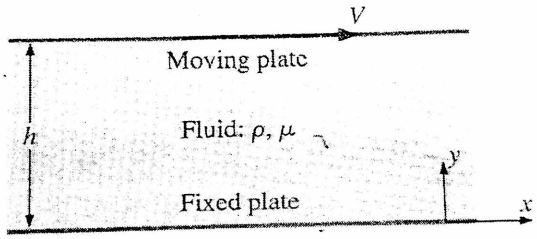

Fig. 2: Couette flow.

3) An open tank of diameter D containing water to depth h_0 is emptied by a smooth orifice at the bottom. Derive an expression for the time taken to reduce the height to h. Also, find the time t_{max} for emptying the tank, shown in Fig. 3. **(10 Marks)**

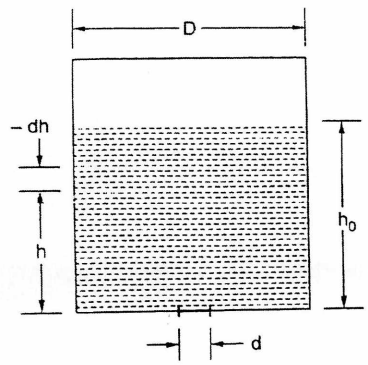

Fig. 3: Open tank system

4) Write the working principle of the reciprocating pump and centrifugal pump and also the difference between them. **(10 Marks)**

5) Oil of viscosity 0.1 Ns/m^2 is to flow through an inclined pipe by gravity. The pipe diameter is 25 mm and the density of the oil is 930 kg/m^3. If the flow rate is to be 0.25 l/s, determine the pipe inclination with horizontal. **(5 Marks)**