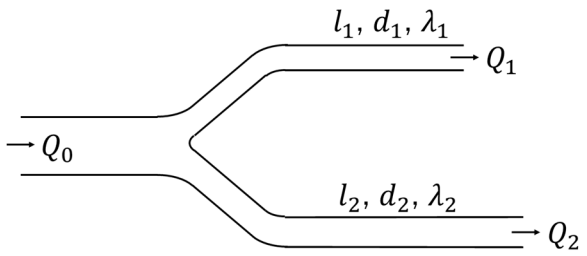
2025 ENTRANCE EXAMINATION FOR INTERNATIONAL MASTER'S PROGRAM
Departments of Mechanical Engineering and Hydrogen Energy Systems

Fluid Engineering (Group A) [10:45~12:15]

Examinee's number _____ Score _____

Ⅰ. Consider a piping system on a horizontal plane, as shown in the right figure. A liquid flows into the pipe on the left with a flow rate of Q_0, and then splits into two branches with lengths and diameters l_1 and d_1, and l_2 and d_2, respectively. The flow discharges into atmosphere at the both ends of the branches without contraction. The flow rates in these branches are Q_1 and Q_2. Note that the pipe friction factors for each pipe are λ_1 and λ_2, and losses at the branching and the bending points are negligible. Express Q_1 using Q_0, l_1, l_2, d_1, d_2, λ_1, and λ_2. (25 points)



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Ⅱ. As shown in the figure, a concentric semi-cylindrical curved plate, which is located orthogonally to the paper and smoothly connected with two flat plates at both ends, is moving to the left with a velocity magnitude u. Water ejected from the stationary nozzle into the atmosphere collides with the curved plate at the bottom edge, flows along the curved surface and then flows away in the opposite direction to the nozzle jet. Let the velocity magnitude of nozzle jet in the stationary frame be V ($V > u$), and the cross-sectional area of jet is A. The density of water is denoted by ρ. Assuming that losses and the effect of gravity are negligible, answer the following questions. (25 points)

(1) Find the flow rate of water coming into the curved plate by using A, V, and u.

(2) Find the magnitude of the fluid force acting on the curved plate per unit length in the orthogonal direction to the paper by using A, ρ, V, and u.

(3) Find the power given to the curved plate per unit length in the orthogonal direction to the paper by using A, ρ, V, and u.