令和 8 年度(2026 年度)　大学院工学府修士課程外国人留学生特別選抜試験（化学工学専攻）
International Master's Programs of Chemical Engineering in the Graduate School of Engineering, Kyushu University (Academic Year from April, 2026)

科　目／Subject：流動／Fluid Dynamics（１枚／1 sheet）

1.　(20 点／20 points)

密度 ρ，粘度 μ をもつ流体が，鉛直方向から角度 θ だけ傾いた平板上に形成された液膜として，重力により定常・層流で流れ落ちている．平板に沿った下向き方向を z，平板に垂直な方向を xとし，自由表面を $x = 0$ ，平板表面を $x = \delta$ とする．速度成分は流れ方向の $u_z(x)$ のみとし，物性値は一定とする．壁面（$x = \delta$）では滑りなし条件が成り立つ．以下の問いに答えよ．／A fluid of density ρ and viscosity μ flows steadily down a plane as a liquid film that is inclined at an angle θ from the vertical direction. A coordinate system is defined such that the z–axis is along the plane in the downslope direction, and the x–axis is normal to the plane. The free surface is located at $x = 0$, and the solid wall is located at $x = \delta$. The flow is two-dimensional, and the only nonzero velocity component is the downslope velocity $u_z(x)$. All physical properties are constant. At the wall the no-slip condition holds. Answer the following questions.

(1.1)　平板に垂直な方向に微小厚さ $\mathrm{d}x$ の要素をとり，z 方向の運動量収支から，液膜内の速度 $u_z(x)$ が従う支配方程式を導け．／Consider a thin shell of thickness $\mathrm{d}x$ in the x-direction and apply the momentum balance in the z-direction to derive the governing differential equation for $u_z(x)$.

(1.2)　適切な境界条件を与え，速度分布 $u_z(x)$ を求めよ／Provide appropriate boundary conditions and determine the velocity distribution $u_z(x)$.

(1.3)　壁面におけるせん断応力を求めよ．／Determine the shear stress on the wall surface.

(1.4)　液膜の単位幅あたりの体積流量を求めよ．／Derive an expression for the volumetric flow rate per unit width of the film.

2.　(30 点／30 points)

内径 50.0 mm の滑らかな 100 m の円管内を，流量が 180 L/min の水が流れている．以下の問に答えよ．なお，水の密度は 1.00×10^3 kg/m^3，動粘度は 1.00×10^{-6} m^2/s とする．／Water flows at a rate of 180 L/min through a smooth circular pipe with an inner diameter of 50.0 mm and a length of 100 m. Answer the following questions. The density of water is 1.00×10^3 kg/m^3, and its kinematic viscosity is 1.00×10^{-6} m^2/s.

(2.1)　管内の流れにおけるレイノルズ数を求めよ．／Calculate the Reynolds number for the flow within the pipe.

(2.2)　ブラジウスの式を使って管摩擦係数を求めよ．／Calculate the friction coefficient using Blasius formula.

(2.3)　圧力損失を求めよ．／Calculate the pressure drop.

(2.4)　壁面におけるせん断応力を求めよ．／Calculate the shear stress on the wall surface.

(2.5)　円管内の速度分布が $n = 7$ の指数法則に従う場合の管中心の速度を求めよ．／Find the velocity at the center of the pipe when the velocity distribution within the circular pipe follows an exponential law with $n = 7$.

(2.6)　円管内の速度分布が対数法則に従う場合の管中心の速度を求めよ．／Find the velocity at the center of the pipe when the velocity distribution inside the circular pipe follows the logarithmic law.