CONCORDIA UNIVERSITY
FACULTY OF ENGINEERING AND COMPUTER SCIENCE
DEPARTMENT OF MECHANICAL ENGINEERING
MID-TERM EXAMINATION
FLUID MECHANICS II, MECH 361/4 Sec. X

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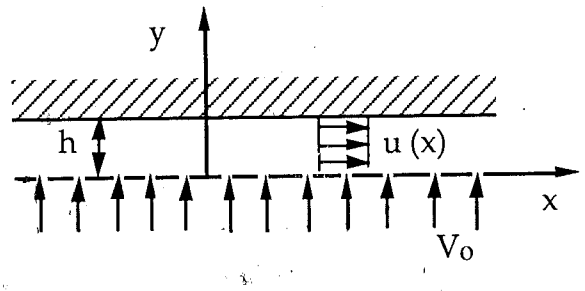
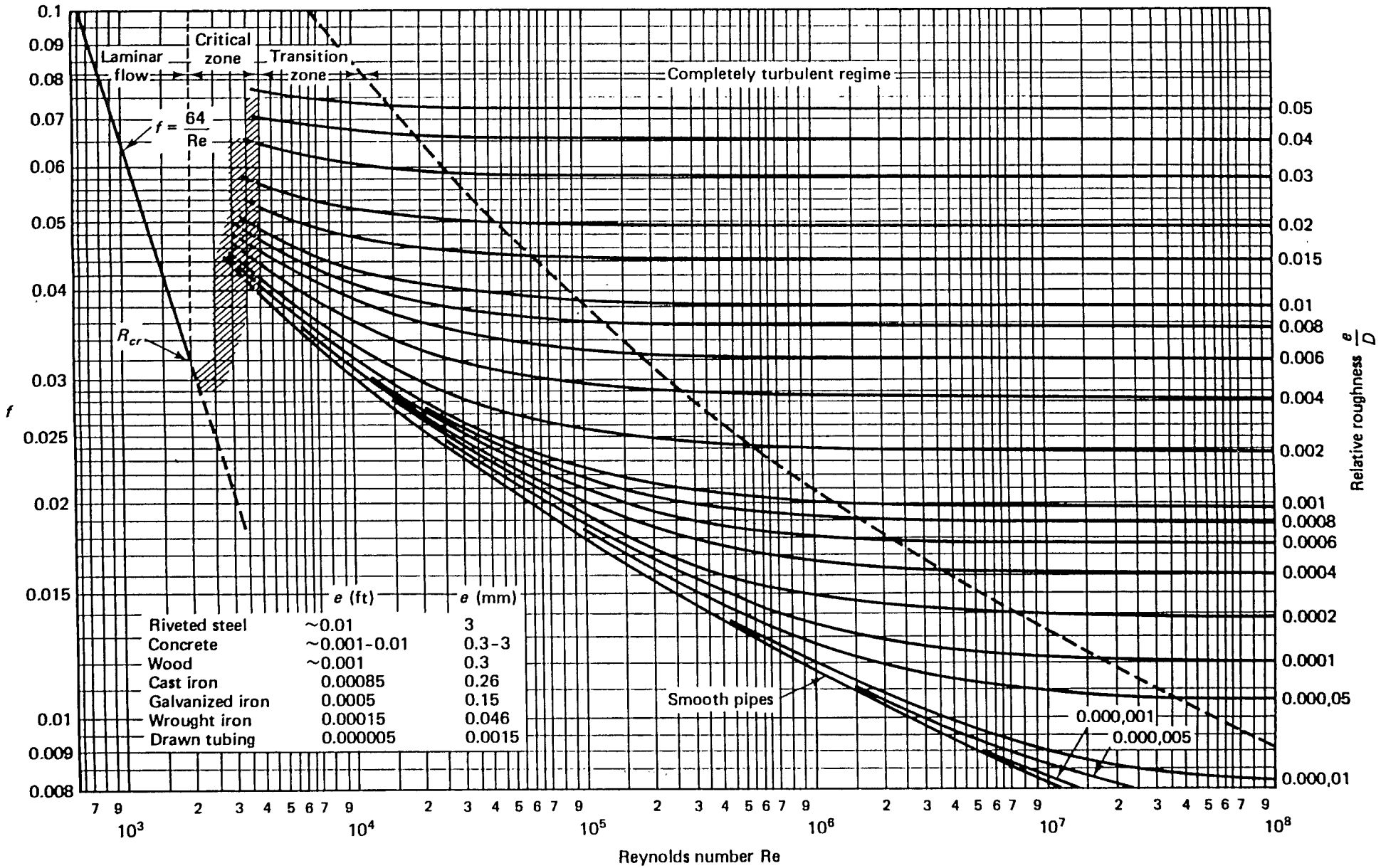
Problem no. 1. (10 marks). Air flows into a narrow gap, of height h, between closely spaced parallel plates trough a porous surface as shown. Use a control volume, with outer surface located at position x, to show that the uniform velocity in the x-direction is $u = V_o\, x/h$. Find an expression for the velocity component in the y-direction. Derive an equation for the acceleration of the fluid particle in the gap.



Problem no. 2. (10 marks). In some locations with very "hard" water, a scale can build up on the walls of pipes to such extend that not only does the roughness increases with time, but the diameter significantly decreases with time too. Consider a case for which the roughness and diameters vary as $\varepsilon = 0.02 + 0.01\ t$ (mm), and $D = 50\ (1 - 0.02t)$ (mm) respectively. The time t is given in years. Calculate the volumetric flowrate in 10 years if the pressure drop per 12 m of horizontal pipe remains constant at $\Delta P = 1.300$ kPa. (assume $\rho_{water} = 1000\ kg/m^3$, and $\nu_{water} = 1.12 \times 10^{-6}\ m^2/s$).



Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)