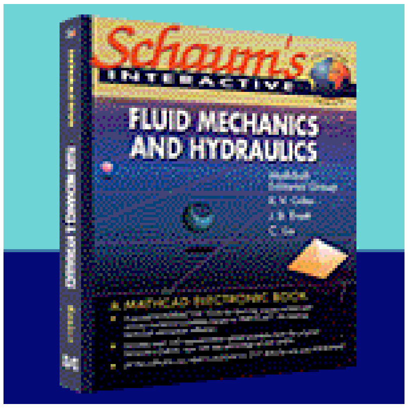
Schaums Interactive Outline Series:

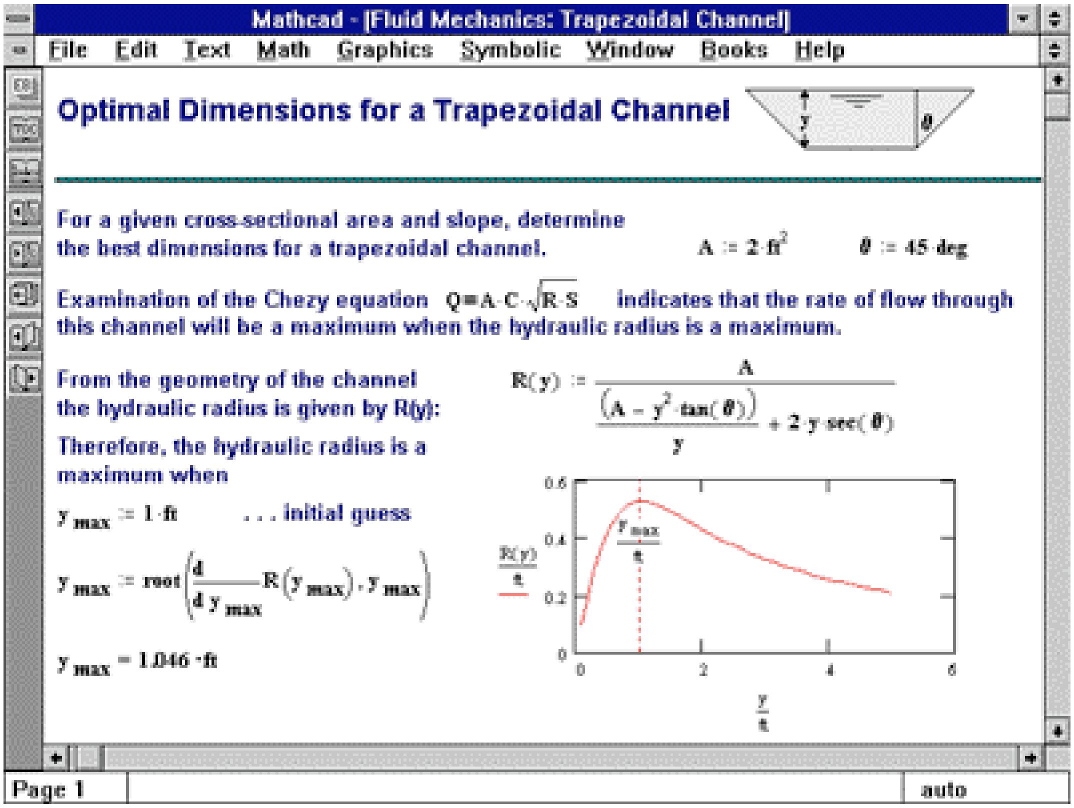
Fluid Mechanics and Hydraulics



Platform: Windows
Includes the Mathcad Engine; requires 4 MB hard disk space
Available for ground shipment

The more than 120 problems and related material in this Electronic Book are designed to supplement standard textbooks in fluid mechanics and hydraulics. The student can explore fundamentals and gain intuition about how various parameters affect the solutions to problems. Physics and engineering educators will find a comprehensive selection of laboratory and homework exercises in Mathcad, with plenty of room for creativity and expansion. Practicing engineers will find detailed solutions to many practical problems and resource information. With the Mathcad Engine built-in you get the benefits of a "live" interface so you can change variables and let Mathcad calculate the results for you. And, the appendices of physical properties and coefficients are a useful addition

Table of Contents | Product Sample | Back to Product List



Given cross-sectional area and slope, use the Chezy equation to optimize the dimensions for a trapezoidal channel.

Topics include: Properties of Fluids, Hydrostatic Force on Surfaces, Buoyancy and Flotation, Dimensional Analysis and Hydraulic Similitude, Fundamentals of Fluid Flow in Conduits, and Open Channels, Measurement of Flow and Fluids, Forces Developed by Moving Fluids, and much more.

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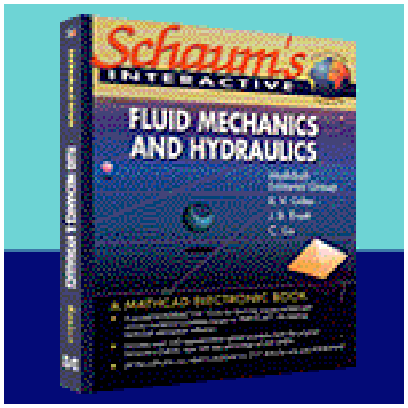


TABLE OF CONTENTS (page 1 of 6)

Schaums Interactive Outline Series:

Fluid Mechanics and Hydraulics

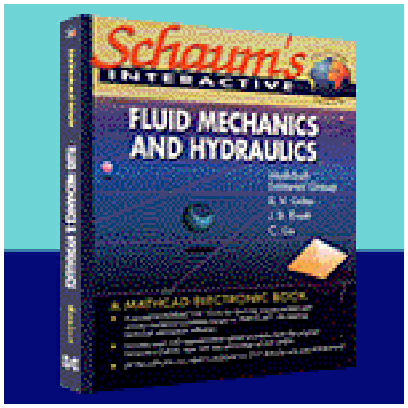


TABLE OF CONTENTS (page 2 of 6)

Product Sample
Back to Product List

Fluid Mechanics and Hydraulics

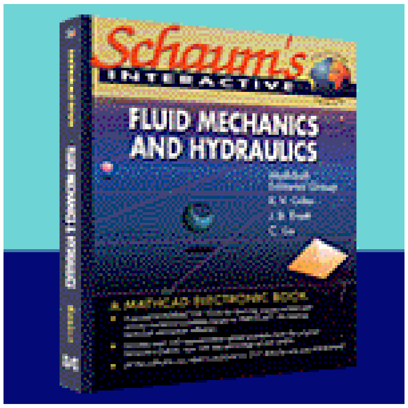


TABLE OF CONTENTS (page 3 of 6)

Product Sample
Back to Product List

Schaums Interactive Outline Series:

Fluid Mechanics and Hydraulics

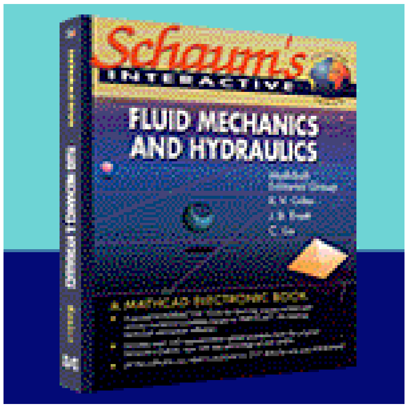


TABLE OF CONTENTS (page 4 of 6)

Schaums Interactive Outline Series:

Fluid Mechanics and Hydraulics

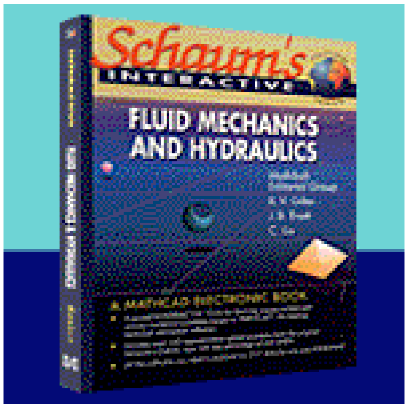


TABLE OF CONTENTS (page 5 of 6)

Product Sample
Back to Product List

Fluid Mechanics and Hydraulics

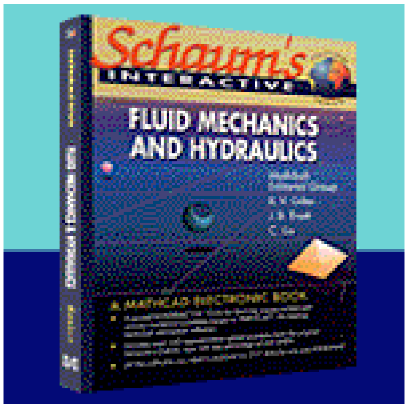


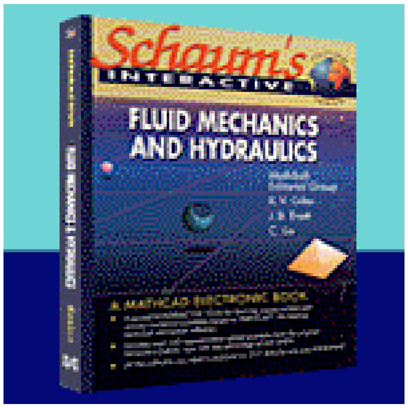
TABLE OF CONTENTS (page 6 of 6)

Chapter 14 Fluid Machinery

Appendix

Product Sample

Back to Product List



Calculating Shear Stress, Shear Velocity, Average Velocity and Friction Velocity

Statement

Determine (a) the shear stress at the walls of a pipe with diameter **d** when water flowing causes a measured head loss of **hL** in a length **L** of the pipe, (b) the shear stress at distance **R** from the centerline of the pipe, (c) the shear velocity, (d) the average velocity for a friction factor **f**, and (e) the ratio **v/vfric**.

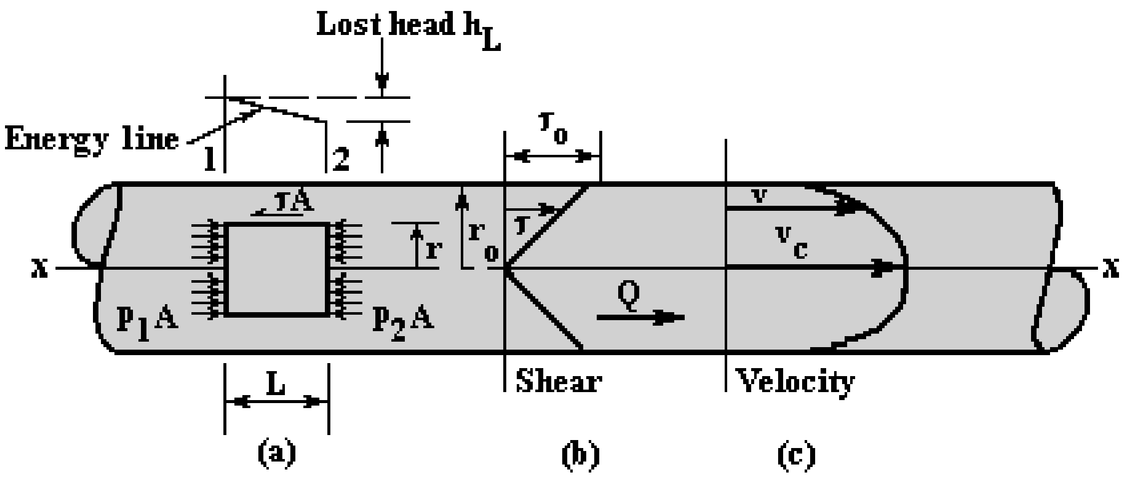
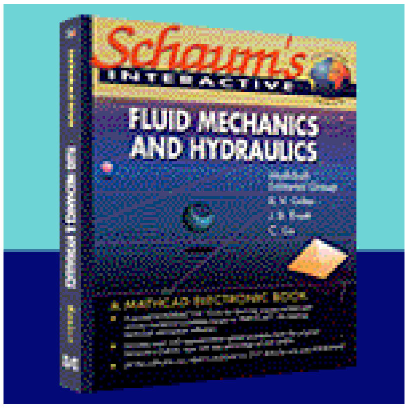


Table of Contents

Back to Product List

Fluid Mechanics and Hydraulics



SAMPLE PAGE (page 2 of 3)

System Parameters

Pipe diameter: $d := 12 \cdot in$

Pipe radius: $r_0 := \frac{d}{2}$

Head Loss: $h_L := 15 \cdot ft$

Length over which hL is measured: $L := 300 \cdot ft$

Radius at which shear stress is to be calculated: $R := 2 \cdot in$

Friction factor: $f := 0.050$

Specific weight of water: $\gamma := 62.4 \cdot \frac{lbf}{ft^3}$

Density of water: $\rho := \frac{\gamma}{g}$

Solution

(a) Using the results of Solved Problem 8.3, when **r = r0** the shear stress at the wall is

$$\tau_0 := \frac{\gamma \cdot h_L \cdot r_0}{2 \cdot L} \qquad \tau_0 = 5.41667 \cdot 10^{-3} \cdot psi$$

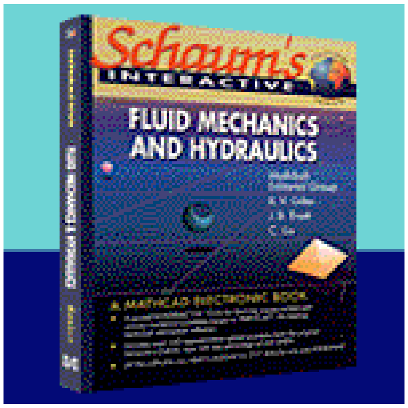
(b) Since t varies linearly from centerline to wall,

$$\tau := \frac{R}{r_0} \cdot \tau_0 \qquad \tau = 1.80556 \cdot 10^{-3} \cdot psi$$

(c) The equation for shear velocity (or friction velocity) from Chapter 8 is

$$v_{fric} := \sqrt{\frac{\tau_0}{\rho}} \qquad v_{fric} = 0.634 \cdot \frac{ft}{sec}$$

Table of Contents
Back to Product List



(d) Using the Darcy-Weisbach formula (see Chapter 8), the average velocity **V** can be determined:

$$h_L = f \cdot \left(\frac{L}{d}\right) \cdot \left(\frac{V^2}{2 \cdot g}\right)$$

Solving for **V** yields

$$V := \sqrt{\frac{d \cdot g \cdot 2 \cdot h_L}{f \cdot L}} \qquad V = 8.02 \cdot \frac{ft}{sec}$$

(e) From the following two equations,

$$\tau_0 = \mu \cdot \frac{v}{y} \qquad \nu = \frac{\mu}{\rho}$$

we obtain (by eliminating **m**)

$$\tau_0 = \nu \cdot \rho \cdot \frac{v}{y} \qquad \frac{\tau_0}{\rho} = \nu \cdot \frac{v}{y}$$

But, from Chapter 8, the S=shear velocity **vfric** is defined as

$$v_{fric}^2 = \frac{\tau_0}{\rho}$$

Therefore, by substitution and rearrangement:

$$v_{fric}^2 = \nu \cdot \frac{v}{y} \qquad \frac{v}{v_{fric}} = \frac{v_{fric} \cdot y}{\nu}$$