

ME 3710

Homework 5

Due Tuesday February 23 at 11:59pm – upload to canvas

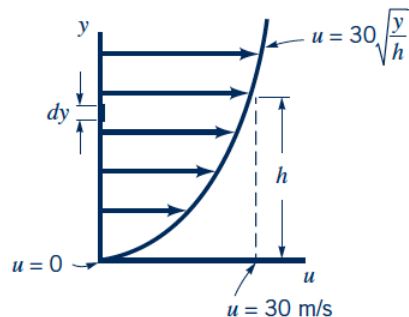
[6 problems – 18 pts]

### Problem 5.2

An incompressible fluid flows horizontally in the  $x$ - $y$  plane with a velocity given by

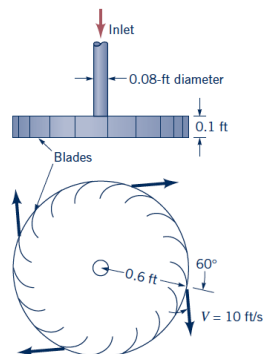
$$u = 30\sqrt{\frac{y}{h}} \quad \text{and} \quad v = 0.$$

where  $y$  and  $h$  are in meters and  $h$  is a constant. Determine the average velocity for the portion of the flow between  $y = 0$  and  $y = h$ .



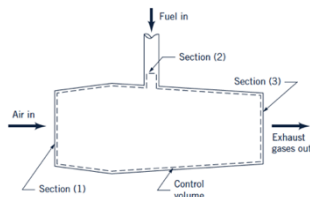
### Problem 5.4

Water flows out through a set of thin, closely spaced blades as shown in the figure below with a speed of  $V = 10$  ft/s around the entire circumference of the outlet. Determine the mass flowrate through the inlet pipe.



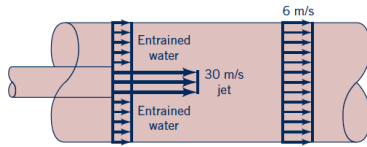
### Problem 5.13

At cruise conditions, air flows into a jet engine at a steady rate of  $65$  lbm/s. Fuel enters the engine at a steady rate of  $0.60$  lbm/s. The average velocity of the exhaust gases is  $1500$  ft/s relative to the engine. If the engine exhaust effective cross-sectional area is  $3.5$  ft<sup>2</sup>, estimate the density of the exhaust gases in lbm/ft<sup>3</sup>.



**Problem 5.17**

A water jet pump (see the figure below) involves a jet cross-sectional area of  $0.01 \text{ m}^2$ , and a jet velocity of  $30 \text{ m/s}$ . The jet is surrounded by entrained water. The total cross-sectional area associated with the jet and entrained streams is  $0.075 \text{ m}^2$ . These two fluid streams leave the pump thoroughly mixed with an average velocity of  $6 \text{ m/s}$  through a cross-sectional area of  $0.075 \text{ m}^2$ . Determine the pumping rate (i.e., the entrained fluid flowrate) involved in  $\text{l/s}$ .

**Problem 5.18**

To measure the mass flowrate of air through a 6-in.- inside diameter pipe, local velocity data are collected at different radii from the pipe axis (see the table below). Determine the mass flowrate corresponding to the data listed in the following table. Plot the velocity profile and comment.

| $r$ (in.) | Axial Velocity (ft/s) |
|-----------|-----------------------|
| 0         | 30                    |
| 0.2       | 29.71                 |
| 0.4       | 29.39                 |
| 0.6       | 29.06                 |
| 0.8       | 28.70                 |
| 1.0       | 28.31                 |
| 1.2       | 27.89                 |
| 1.4       | 27.42                 |
| 1.6       | 26.90                 |
| 1.8       | 26.32                 |
| 2.0       | 25.64                 |
| 2.2       | 24.84                 |
| 2.4       | 23.84                 |
| 2.6       | 22.50                 |
| 2.8       | 20.38                 |
| 2.9       | 18.45                 |
| 2.95      | 16.71                 |
| 2.98      | 14.66                 |
| 3.00      | 0                     |

**Problem 5.27**

Estimate the time required to fill water in a cone-shaped container (see the figure below) 5 ft high and 5 ft across at the top if the filling rate is  $20 \text{ gal/min}$ .

