Mass flow meter
Vortex Shedding Flow Meter

- As fluid flows past a cylinder or other object, alternating vortices are shed off the trailing edge.
- Vortex frequency described by Strouhal No.
  \[ St = \frac{fD}{V} \]
- For cylinder, \( St = \sim 20.5 \) for \( 500 < Re < 10^5 \)
- Over this range of constant \( St \), a measurement of vortex frequency \( f \) is directly proportional to \( V \)
Several different shapes can be placed in the flow, with varying ranges of Re over which St is constant.

Vortex frequency f is measured by several different methods.

The picture on the following page shows measurement by an ultrasonic transmitter and receiver.
Vortex Shedding Meter

Flow

Obstruction

Pipe

Vortices

Ultrasonic transmitter

Beam of vibrations

Ultrasonic receiver
Ultrasonic Doppler Flow Meter

- Ultrasound can also be used to measure flow rates in ultrasonic transit time meters or ultrasonic Doppler meters.
- These meters measure either transit time or frequency shift of emitted/received waves that bounce off of particles and bubbles in fluid.
- These meters are completely non-obtrusive (but not cheap!)
Ultrasonic Doppler

FIGURE 7-21
Ultrasonic doppler flowmeter.