Turbomachines

Lecture 29–30

ME EN 412
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Outline

Introduction

Introduction

Which of the following are turbomachines?

- gas turbine engine
- jet engine
- compressor
- wind or water turbine
- propeller
- fan
- centrifugal pump
- blender

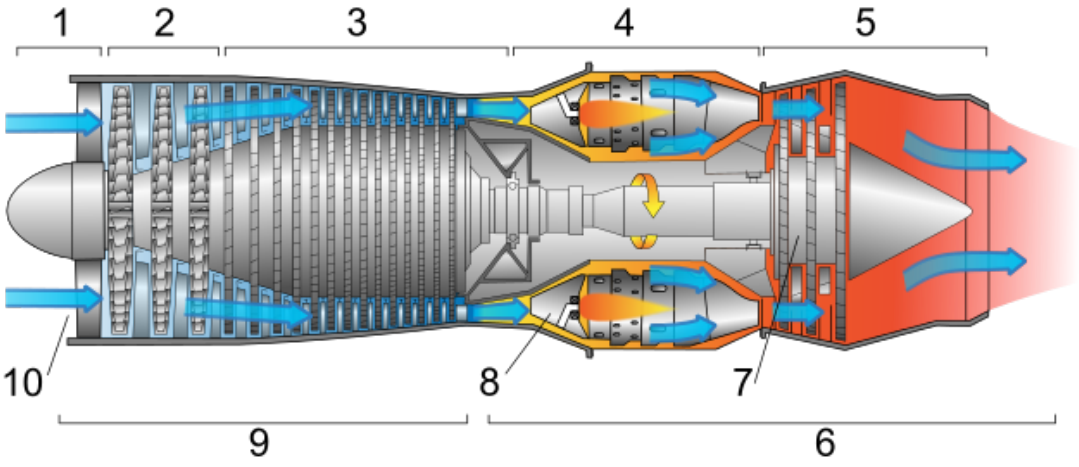
Turbomachines: mechanical devices that transfer energy between a rotor and a fluid.

turbine: extracts energy from the fluild.

pump/compressor/propeller/fan: adds energy to the fluid.

Open and Closed

Direction of fluid motion



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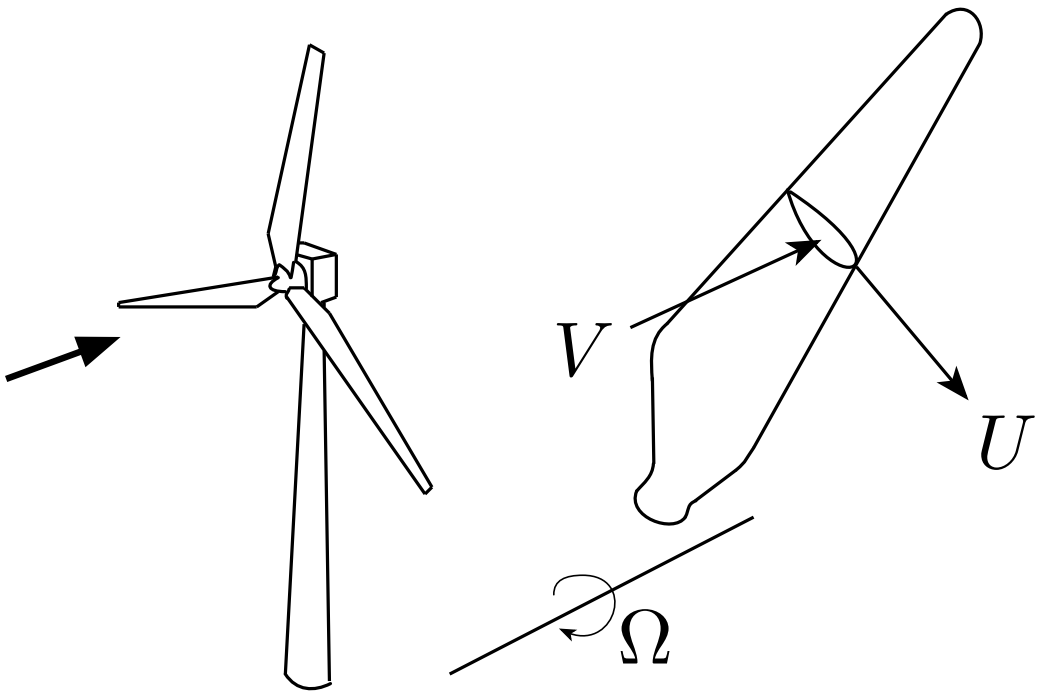
Velocity Triangles

Velocity Triangles



$$V = W + U_\theta$$

W: relative velocity

V: absolute velocity

U_θ: blade velocity

Video: https://youtu.be/Wh4Furbn1Gk

fan or turbine?

Angular Momentum Balance

Angular Momentum Balance

$$\frac{\partial}{\partial t}\int_V \rho(\vec{r}\times\vec{V})dV + \int_S (\vec{r}\times\vec{V})(\rho\vec{W}\cdot d\vec{A}) = \sum(\vec{r}\times\vec{F})$$

Usually the problems we are interested in are steady (in a time-averaged sense)

$$\int_S (\vec{r} \times \vec{V})(\rho \vec{W} \cdot d\vec{A}) = \sum (\vec{r} \times \vec{F})$$

Or for convenience:

$$\int_S (\vec{r} \times \vec{V}) \dot{m} = \sum \vec{T}$$

Examples

- Ex. 5.18
- P 12.8
- P 12.10
- P 12.3
- P 12.12