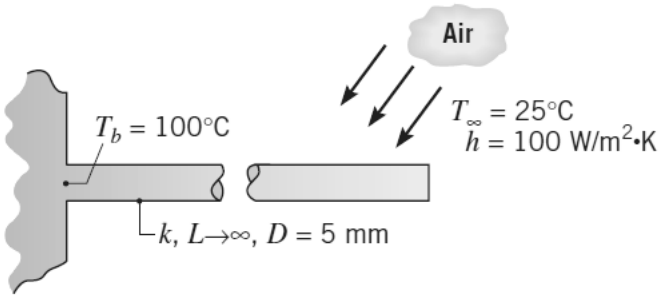
# Tutorial Four

| *Extended surfaces, fins* |

## Problem 4.1

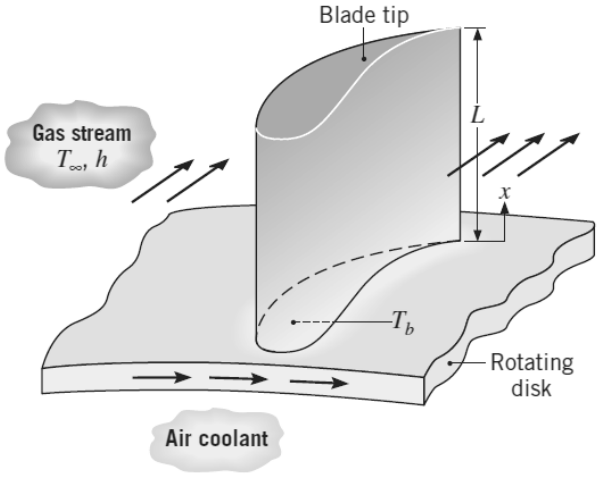
A very long rod **5 mm** in diameter has one end maintained at **100°C**. The surface of the rod is exposed to ambient air at **25°C** with a convection heat transfer coefficient of **100W/m$^2$·K**.




1. Determine the temperature distributions along rods constructed from pure copper, 2024 aluminum alloy, and type AISI 316 stainless steel. What are the corresponding rates of heat loss from the rods?
2. Estimate how long the rods must be for the assumption of infinite length to yield an accurate estimate of the rate of heat loss.

## Problem 4.2

Turbine blades mounted to a rotating disc in a gas turbine engine are exposed to a gas stream that is at **$T_\infty$ = 1200°**C and maintains a convection coefficient of **h = 250 W/m$^2$·K** over the blade.



The blades, which are fabricated from Inconel, **k ≈ 20 W/m·K**, have a length of **L = 50 mm**. The blade profile has a uniform cross-sectional area of $\mathbf{A_c = 6 \times 10^{-4}\ m^2}$ and a perimeter of **P = 110 mm**. A proposed blade cooling scheme, which involves routing air through the supporting disc, is able to maintain the base of each blade at a temperature of $\mathbf{T_b = 300°C}$.

1. If the maximum allowable blade temperature is **1050°C** and the blade tip may be assumed to be adiabatic, is the proposed cooling scheme satisfactory?
2. For the proposed cooling scheme, what is the rate at which heat is transferred from each blade to the coolant?

## Problem 4.3

A brass rod **100 mm** long and **5 mm** in diameter extends horizontally from a casting at **200°C**. The rod is in an air environment with $\mathbf{T_\infty = 20°C}$ and $\mathbf{h = 30\ W/m^2{\cdot}K}$. What is the temperature of the rod **25**, **50**, and **100 mm** from the casting?

## Problem 4.4

A straight fin fabricated from 2024 aluminum alloy (**k = 185 W/m·K**) has a base thickness of **t = 3 mm** and a length of **L = 15 mm**. Its base temperature is $\mathbf{T_b = 100°C}$, and it is exposed to a fluid for which $\mathbf{T_\infty = 20°C}$ and $\mathbf{h = 50\ W/m^2{\cdot}K}$. For the foregoing conditions and a fin of unit width, compare the fin heat rate, efficiency, and volume for **rectangular**, **triangular**, and **parabolic** profiles.