

**Birzeit University**  
**Mechanical & Mechatronics Engineering Department**  
**Heat Transfer ENME 431**  
**Homework # 8 Chapter 9 Free Convection**

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**9.11** Beginning with the free convection correlation of the form given by Equation 9.24, show that for air at atmospheric pressure and a film temperature of 400 K, the average heat transfer coefficient for a vertical plate can be expressed as

$$\bar{h}_L = 1.40 \left( \frac{\Delta T}{L} \right)^{1/4} \quad 10^4 < Ra_L < 10^9$$

$$\bar{h}_L = 0.98 \Delta T^{1/3} \quad 10^9 < Ra_L < 10^{13}$$

**9.41** A circular grill of diameter 0.25 m and emissivity 0.9 is maintained at a constant surface temperature of 130°C. What electrical power is required when the room air and surroundings are at 24°C?

**9.60** A horizontal electrical cable of 25-mm diameter has a heat dissipation rate of 30 W/m. If the ambient air temperature is 27°C, estimate the surface temperature of the cable.

**9.77** A sphere of 25-mm diameter contains an embedded electrical heater. Calculate the power required to maintain the surface temperature at 94°C when the sphere is exposed to a quiescent medium at 20°C for: (a) air at atmospheric pressure, (b) water, and (c) ethylene glycol.

**9.92** Consider a horizontal flat roof section having the same dimensions as a vertical wall section. For both sections, the surfaces exposed to the air gap are at 18°C (inside) and -10°C (outside).

(a) Estimate the ratio of the convection heat rate for the horizontal section to that of the vertical section.

