UNIVERSITY HAMMA LAKHDAR OF EL-OUED
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1st Y. Sc. Masters in Energetics
Intermediate Heat & Mass Transfer

Series N°1: Generalities, & Thermal conduction

Ex.01: Consider an incandescent lamp with a power of 150 W. The filament of the lamp is 5 cm long and has a diameter of 0.5 mm. The diameter of the glass bulb of the lamp is 8 cm. Determine the heat flux, in W/m^2, **(a)** on the surface of the filament, and **(b)** on the surface of the glass bulb. **(c)** Calculate how much it will cost per year to keep this lamp illuminated for eight hours a day, every day, if the unit cost of electricity is 6.32 DA/kWh.

Ex.02: On a hot summer day, a student turns on his fan when he leaves his room in the morning. When he returns in the evening, will his room be hotter or cooler than the neighboring rooms? Why? Assume that all doors and windows are kept closed.

Ex.03: Consider a person standing in a room at $23°C$. Determine the total rate of heat transfer from this person if the exposed surface area and the skin temperature of the person are 1.7 m^2 and $32°C$, respectively, and the convective heat transfer coefficient is 5 $W/m^2.°C$. Take the emissivity of the skin and clothing to be 0.9 and assume that the temperature of the room's internal surfaces is the same as the air temperature.

Ex.04: Someone has claimed that a *microwave* oven can be viewed as a conventional oven with *zero convective* resistance at the surface of the food. Is this statement accurate?

Ex.05: Consider a brick wall (thermal conductivity, $\lambda = 0.8\ W/m \cdot °C$) with dimensions of 4 m in height, 6 m in width, and 0.3 m in thickness. On a certain day, the temperatures of the interior and exterior surfaces of the wall are measured to be $14°C$ and $6°C$, respectively. Determine the *heat loss* through this wall.

Ex.06: Two aluminum bars (thermal conductivity, $\lambda = 176\ W/m \cdot °C$) with diameters of 5 cm and lengths of 15 cm are pressed against each other with a pressure of 20 atm. The bars are enclosed in an insulated sleeve, so the heat transfer from the lateral surfaces is negligible. If the ends of the two-bar system (top and bottom) are maintained at temperatures of $150°C$ and $20°C$, respectively, determine **(a)** the heat transfer rate along the cylinders under steady-state conditions, and **(b)** the temperature drop at the interface. The contact conductance at the aluminum-aluminum interface is given as $h = 11400\ W/m^2 \cdot °C$. (Answers: **(a)** 142.4 W, **(b)** $6.4°C$)

Ex.07: A spherical reservoir with an internal diameter of 5 m is constructed with a 1.5 cm thick layer of stainless steel (thermal conductivity, $\lambda = 15\ W/m \cdot °C$) and is used to store ice-cold water at $0°C$. The reservoir is placed in a room with a temperature of $30°C$. The walls of the room are also at $30°C$. The exterior surface of the reservoir at $5°C$ is considered black (emissivity, $\varepsilon = 1$), and heat transfer between the exterior surface of the reservoir and the surroundings occurs through natural convection and radiation. The heat transfer coefficients by convection for the interior and exterior surfaces of the reservoir are $80\ W/m^2 \cdot °C$ and $10\ W/m^2 \cdot °C$, respectively. Determine **(a)** the heat transfer rate to the ice-cold water in the reservoir, and **(b)** the amount of $0°C$ ice that melts during a 24-hour period. The heat of fusion of water at atmospheric pressure is $h_{gf} = 333.7\ kJ/kg$.