Abdelhafid Boussouf University Center – Mila
Institute of Science & Technology
Dr. BOUTI .m *Process Engineering – L3*

Tutorial – One

| *Heat Transfer – Basic Modes of Heat Transfer* |

Conduction

Exercise 1

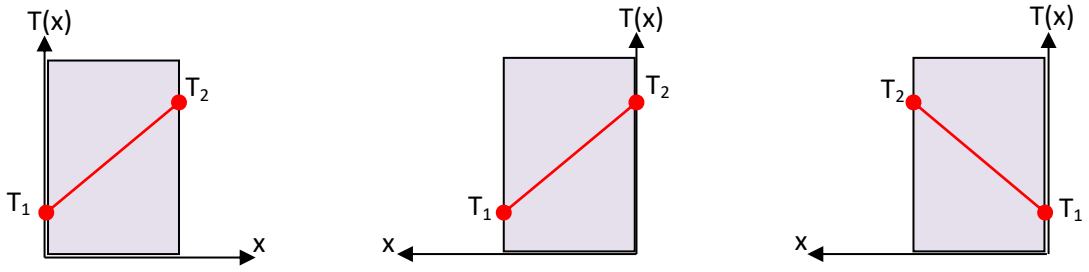
The heat flux through a wood slab **50 mm** thick, whose inner and outer surface temperatures are **40** and **20 °C**, respectively, has been determined to be **40 W/m²**. What is the thermal conductivity of the wood?

Exercise 2

A freezer compartment consists of a cubical cavity that is **2 m** on a side. Assume the bottom to be perfectly insulated. What is the minimum thickness of Styrofoam insulation (**k = 0.030 W.m^{-1}.K^{-1}**) which must be applied to the top and side walls to ensure a heat load less than 500 W, when the inner and outer surfaces are **-10 °C** and **35 °C**?.

Exercise 3

Consider a plane wall **100 mm** thick and of thermal conductivity **100 W.m^{-1}.K^{-1}**. Steady-state conditions are known to exist with **T_1 = 400 K** and **T_2 = 600 K**. Determine the heat flux (q''_x) and the temperature gradient ($\frac{dT}{dx}$) for the coordinate systems shown.



(a) (b) (c)

Convection

Exercise 4

Air at **20 °C** blows over a hot plate **50** by **75 cm** maintained at **250 °C**. The convection heat transfer coefficient is **25 W/m^2.°C**. Calculate the heat transfer rate.

Exercise 5

Consider a **0,8 m** high and **1,5 m** wide glass window with a thickness of 8 mm and a thermal conductivity of **k = 0,78 W.m^{-1}.K^{-1}**. Determine the steady rate of heat transfer through this glass window and the temperature of its inner surface for a day during which the room is maintained at **20 °C** while the temperature of the outdoors is **-10 °C**. Take the heat transfer coefficients on the inner and outer surfaces of the window to be

$$h_1 = 10\ W.m^{-2}.K^{-1} \text{ and } h_2 = 40\ W.m^{-2}.K^{-1}$$

which includes the effects of radiation.

Radiation

Exercise 6

The inner and outer surfaces of a **25 cm** thick wall in summer are at **27°C** and **44°C**, respectively. (See diagram). The outer surface of the wall exchanges heat by radiation with surrounding surfaces at **40 °C**, and convection with ambient air also at **40 °C** with a convection heat transfer coefficient of **8 W/m^2.°C**. Solar radiation is incident on the surface at a rate of **150 W/m^2**. If both the emissivity and the solar absorptivity of the outer surface are **0,8** ; determine the effective thermal conductivity of the wall.