LAB ACTIVITY #1
Human-Environment Interaction and Comfort

Overview:

We will perform measurements in the ICE climatic chamber (Fribourg), and collect data (objective and subjective) that will help you to practice and better understand human energy balance and measurements.

What exactly do you have to do?

- *Experience* various thermal environments and *rate* thermal sensation/comfort while modes of convection and radiation in the room will be primarily varied
- The range of thermal exposure will be within *tolerable limits* of 18-28°C.

Required preparations:

- **Dress code:** A dark coloured T-shirt (preferably black), pants (e.g., jeans), socks, sport shoes (no boots, if possible). You can have *an extra top layer*, that should be taken off before going inside the chamber

The following data will be collected:

- **Environment measurements:**
  1. Globe temperature (^{o}C) using a "ping-pong" ball (40 mm) at 0.1, 0.6, 1.1 m
  2. Air temperature (^{o}C) at 0.1, 0.6, 1.1 m
  3. Air speed (m/s) using omnidirectional anemometers at 0.1, 0.6, 1.1 m
  4. Mean radiant temperature (^{o}C) using a CUBE sensor, at 0.6 m
  5. Relative humidity (%), overall for the chamber
  6. Atmospheric pressure, overall for the chamber
- **Personal measurements:**
  1. Heat flux (W/m^2) using wearable sensors placed at two locations (chest and non-dominant hand)
  2. Temperature (^{o}C) using wearable sensors placed at two locations (chest and non-dominant hand)
  3. Thermal comfort surveys (responded every 10 min)

Notes:

- A file with air properties at different temperatures is provided.
- You are free to use any kind of software to analyse your data
- Format of the report – PDF file

Using the collected data, you should collaborate with your group to complete three assigned tasks. Well-detailed answers should be submitted as a group report. The report will be evaluated based on the depth of the responses and the strength of the arguments, which should be well-supported by the data. Additionally, a presentation summarizing the results should be presented on April 4th (every person should participate).

Task 1: Evaluate thermal comfort based on the physical measurements and subjective questionnaires

A. Overall comfort:

1) Calculate the *local* and *mean operative temperature* using the measured parameters (use the globe temperature measurements to determine the mean radiant temperature)

2) Analyse the overall body thermal comfort by estimating the PMV index

3) Discuss the thermal comfort estimated using the PMV index with regard to the standard requirements

4) Compare the *thermal comfort estimation* with *your subjective answers* to the surveys

B. Local discomfort:

1. Determine *the draught rate* for each measurement height and evaluate if they were within the acceptable (standard) range.

2. Determine *radiant temperature asymmetry* using the CUBE sensor measurements and evaluate if it was within the acceptable (standard) range.

Task 2: Evaluate the heat exchange between the body and the environment

1. Estimate your metabolic rate.
2. Determine the temporal change of heat losses (per mode) from the two sites of the human body using the measured data (compute the required intermediate values):
   a) Radiative heat transfer from the body
   b) Convective heat losses from the body
   c) Convective heat losses via respiration
   d) Evaporative heat loss in the skin
   e) Evaporative heat losses via respiration
3. Discuss the inter-individual differences in measurements, and identify the influencing factors.
4. Discuss the correlation between the heat balance determined in Task 2 with the thermal comfort measurements in Task 1.

Task 3: Evaluation of T_{mrt} measurements

Compare the discrepancy between the **mean radiant temperature** T_{mrt} measured using two methods:

a) Using the globe temperature measured using grey "ping-pong" balls (40 mm)

b) *Using the radiant temperature measurements from the CUBE sensors*