**MARMARA UNIVERSITY**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**ME4111/ME4011/ME411 EXPERIMENTAL METHODS IN MECHANICAL ENGINEERING**

**EXPERIMENT NO. 3**

**DESIGN OF AN EXPERIMENT FOR ESTIMATING THE EQUILIBRIUM TEMPERATURE**

1. **Objective**

This experiment aims at estimating the equilibrium temperature of two water samples having different initial temperatures and different masses by fitting a curve to the measured data.

1. **Introduction**

Two thermodynamic systems are in thermal equilibrium when there is no heat transfer between them. In other words, the final temperatures of the two interacting substances will be equal to each other after enough time has elapsed. In the current experiment, two water samples having different initial temperatures are to be considered. Their temperatures will be measured and recorded for a time to be specified. Then, their thermal equilibrium temperature will be estimated by fitting a curve to experimental data.

1. **Theoretical background**

Consider two samples of water having masses *m*1 and *m*2, and initial temperatures *T*1 and *T*2, respectively, as shown schematically in Fig. 1(a). After equilibrium has been reached, the final temperatures of the two samples will be equal to each other, as illustrated in Fig. 1(b).









**a)**

**b)**

**Fig. 1.** Schematic drawing of the experimental setup **(a)** at the initial conditions, **(b)** after the equilibrium has been reached.

Neglecting energy losses to the surroundings, and recalling the first law of thermodynamics, one can write

 (1)

where *mi* (*i* = 1, 2) is the mass of the *i*th sample, *cp* is the specific heat of water, and *∆Ti* is the change in the temperature of the *i*th sample (*i* = 1, 2).

1. **Experimental procedure**

* Measure and record the volumes of the two water samples.
* Measure and record the initial *T*1 and *T*2.
* Measure and record the temperatures of both samples for a time that is specified to you in the lab session.

1. **Required calculations**

* Determine the masses of the two samples.
* Estimate the equilibrium temperature by fitting a curve to the experimental data.
* Calculate the equilibrium temperature by using Eq. (1).
* Calculate the error between the two equilibrium temperatures that are obtained in the above two steps.

1. **Required report format**

* The report should be organized as follows: Title Page, Introduction, Experimental Setup and Procedure, Theoretical Background and Calculation Details, Results and Discussion, Conclusions, References and Appendices (if any).
* Measured and calculated quantities should be presented in tabular form.
* Show all details of your calculations.
* Discuss the possible sources of errors.
* Make recommendations for improving the experimental procedure.