**ABE 303 Exam 1 Practice**

**Time Allowed: ONE (1)** hour - 15 minutes

**Answer All Questions (100 MARKS)**

**Only an annotated summary of useful equations can be used**

**Question 1** (Be brief and effective in answering these questions)

(a) Draw diagrammatic plots of

(i) Thermal conductivity versus temperature

(ii) Heat capacity versus temperature

The plots should include a temperature range from temperatures below 0oC to temperatures above 0oC for a typical non-fatty biological material. Clearly label the axes of each plot, giving units. Briefly explain what these two thermophysical properties mean and how they are used to describe biological processes. **(20 marks)**

(b) Based on the fact that the thermal conductivity of ice is about four times larger than the thermal conductivity of liquid water compare freezing and thawing times of a “rectangular” piece of material. Assume that heat transfer is happening only in one direction (1D) and that the properties of the frozen and thawed biomaterial can be approximated by the properties of ice and water respectively. **(20 marks)**

(c) It is a common practice in the meat industry to use NaCl and/or other salts to produce cured meat products. Although, many of these products have not been cooked they are very stable have long shelf life and are rarely microbiologically spoiled. Based on what you know about water activity explain the reason why the addition of salt improves the shelf life of these products.  **(10 marks)**

**[50 marks]**

**Question 2**

**(a)** Blocks of a **frozen** non-fatty fish are to be tempered, i.e. heated to a temperature somewhat less than the initial freezing point of the fish, in a continuous oven. The blocks enter the oven at -25oC and are required to leave the oven at -4oC.

If the oven is capable of generating 32kW of heat energy in the frozen fish, what will be the maximum possible throughput of the oven in kg fish per hour?

**Data**

Water content of **the non-fatty fish** = 77% (w/w)

Initial freezing point of the fish = -1oC

Bound water content of fish = 0.33 kg water/kg dry solids

Specific heat of the fish solids = 1.9 kJ/kg.K

Specific heat of water = 4.2 kJ/kg.K

Specific heat of ice = 2.1 kJ/kg/K

Latent heat of fusion of water substance = 320 kJ/kg

**(b)** Comment (**do not calculate**) in terms of energy saving and quality what would happen if the initial freezing point of the fish is lowered to -6oC. What would you use to decrease the initial freezing point of the fish? **(20 marks)**

**[50 marks]**