Problem Solving Block B: Iceberg Challenge

Task B4.1

You are consulted by a company to assess the economic potential of the iceberg towing scheme. The company proposes to lasso an iceberg off the coast of Greenland, and tow it 2000km to the South-East of England.

(a) Estimate how large an iceberg can feasibly be towed by a 10,000 kW tug-boat at a speed of 1m/s. Take the density of sea-water to be 1025 kg/m^3.

(b) Estimate how much the iceberg would melt during its journey, if the average sea temperature is 8^{o}C.

(c) If the iceberg is sold to the water company at 1p per litre, do you think the scheme is economically feasible? Assume that marine fuel costs 80p per litre, has a calorific content of 35MJ per litre, and that the tug's engine efficiency is 30%.

Task B4.2

Since the iceberg is melting over time during the journey, the next level of complexity is to include the time-dependence of the iceberg's speed if the tug pulls at constant power.

(a) Write down the iceberg radius as a function of time, and then the pulling speed as a function of time.

(b) How are the total journey time, journey length and the time-dependent speed related? Derive an expression for the final iceberg radius as a function of initial iceberg radius. (Hint: the final radius is related to initial radius and the journey time).

(c) Now you know how the final radius depends on initial radius, you can calculate the income from selling the delivered iceberg and the fuel costs of the tug. Develop a Matlab script to plot the gross profit (sales minus fuel costs) as a function of initial iceberg size.

(d) Use your Matlab work to find the following:

i. The minimum initial iceberg size for the sales revenue to be greater than the given fuel costs (positive gross profit);

ii. The initial iceberg radius and associated gross profit if the total journey time is limited to 30 days due to seasonal factors;

iii. What these will be if the fuel price increases to 140p per litre.