ME2 Computing- Tutorial 9: 3D interpolation with unstructured grids

Learning outcomes:

- Being able to interpolate over a triangle with various methods
- Being able to interpolate over triangulated mesh

Before you start

In your H drive create a folder *H:\ME2CPT\Tutorial9* and work within it.

Introduction

Refer to the slides and the Panopto video for a more comprehensive explanation of what requested in these tasks.

Task A: Interpolation over a triangle: inverse distance method

Write a function *TrNN*, to interpolate three points with the inverse distance method. The function receives the coordinates of three points (r_1, r_2, r_3) and the values of the mathematical function at these three points (f_1, f_2, f_3), and the coordinates of a fourth point r_p, coplanar with the first three ones, and returns the interpolated value $f(r_p)$.

Answer Quiz 1

Task B: Interpolation over a triangle: barycentric coordinates

Write a function *TrBaryc*, to interpolate three points with the barycentric coordinates method. The function has same input and output arguments as in Task A.

Answer Quiz 2

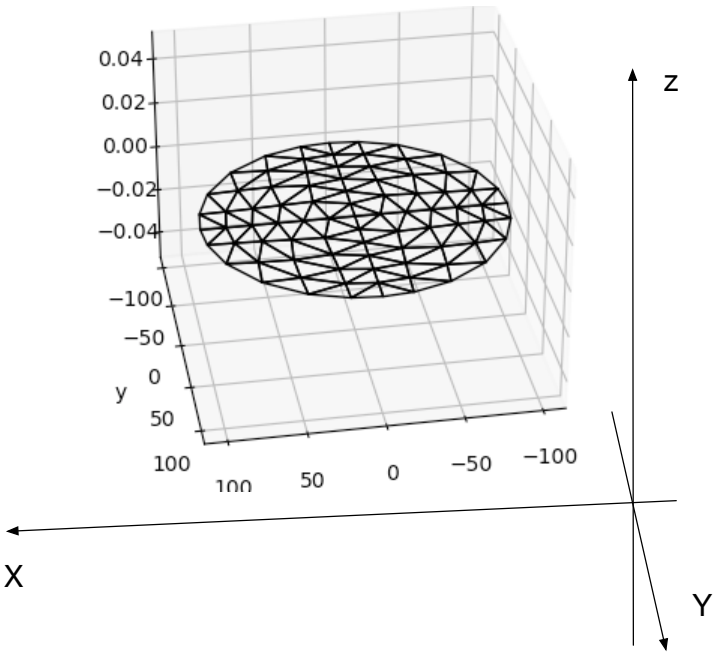
Task C: Interpolation over a triangulated mesh

An electrical circular cooking hob, with radius $\mathrm{r} = 50\mathrm{mm}$, laying in the $\mathrm{x} - \mathrm{y}$ plane, is represented with an unstructured mesh grid of triangular elements. The spatial temperature distribution across the hob is provided for each node of the mesh, in the file *Hob.Temperature.txt*.

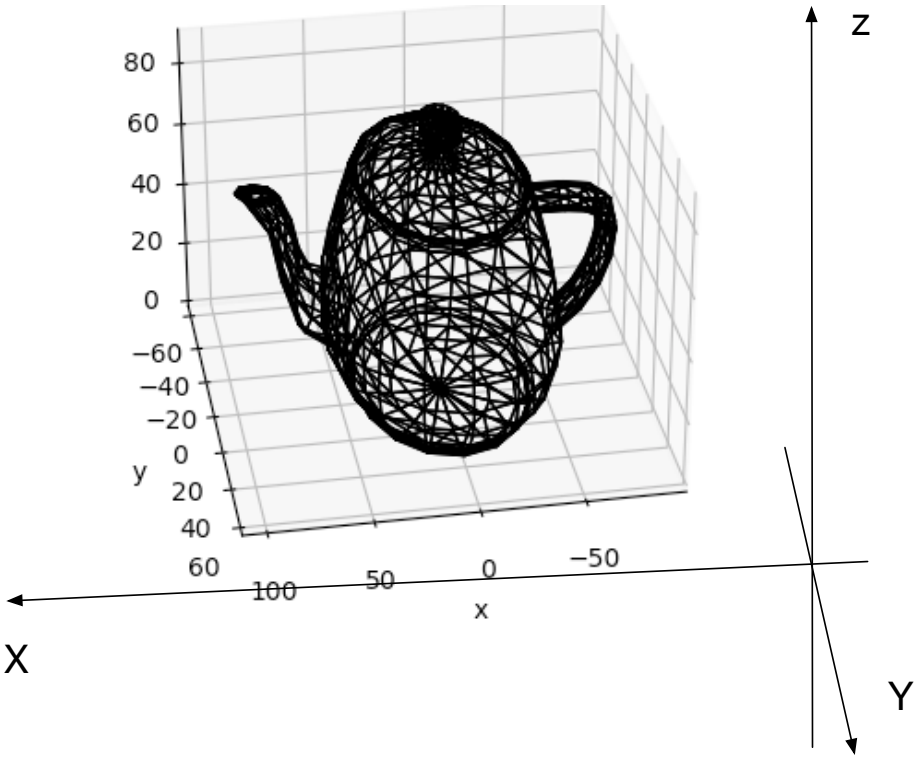
1. Read in the triangled mesh grid, from the two files *Hob.Elements.txt* and *Hob.Nodes.txt*, containing the triangle elements and the discrete nodes of the circular hob, respectively.

2. Read in the file *Hob.Temperature.txt*, containing the nodal temperature distribution.

3. Plot the mesh grid: both the elements and the nodes.



A tea pot is positioned on top of the hob. The tea pot is also represented with a set of unstructured triangular meshes, stored in files *TeaPot.Elements.txt* and *TeaPot.Nodes.txt*.

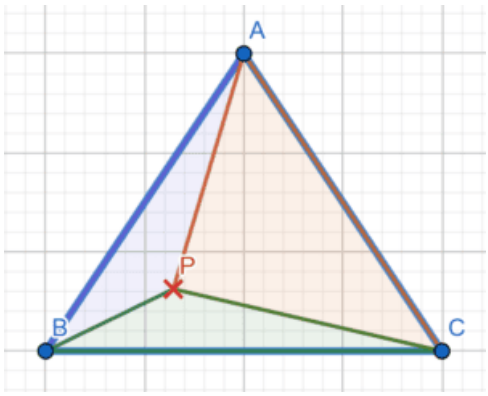


The discrete nodes at the base of the teapot ($z = 0$) do not correspond necessarily to the nodes of the discrete hob.

For each nodal point at the base of the teapot ($z = 0$):

1. Determine the corresponding triangular element of the hob mesh, containing the nodal point of the teapot.

   Method for determining if a point P is internal to a triangle ABC:
   - Determine the areas of the three sub triangles ABP, PCA and BCP.
   - Determine the area of the triangle ABC.
   - If the sum of the areas of the three sub triangles is equal to the area of ABC, point P lays inside the triangle ABC.



   - The area of a triangle ABC can be computed as the cross product of the two vectors $(B - A)$ and $(C - A)$:

$$\frac{|(B - A) \times (C - A)|}{2}$$

2. By making use of the hob temperatures at the three nodal points of the embedding element determined in 1), interpolate the temperature of the teapot at the nodal point under consideration.