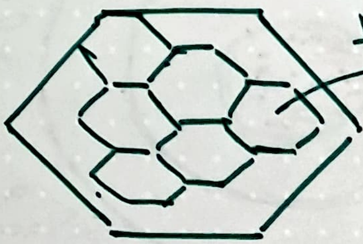
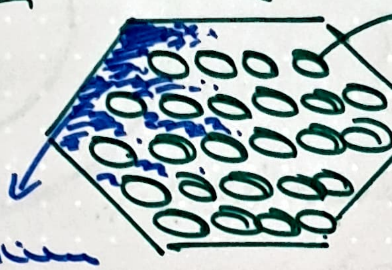
Report - Assignment #1:

· **Problem**:

· Nuclear Reactor modeling:

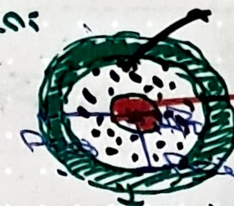


fuel Assembly



fuel pin:

Sodium cooling.



inert gas.

fuel.

cladding

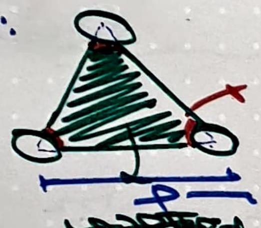
R_{ff}: fuel pellet outer radius:

R_{ci}: cladding inner radius:

R_{co}: cladding outer radius.

· **Unit cell**: 3 fuel pins: (geometry):

· **Definition**:



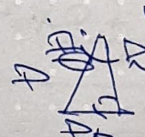
wetted perimeter: P_w

$3 \times \frac{1}{6}\pi R_{co}^2$

p pitch.

~~wetted~~

Flow area: $A = \frac{h \times p}{2} - \frac{\pi R_{co}^2}{2}$.



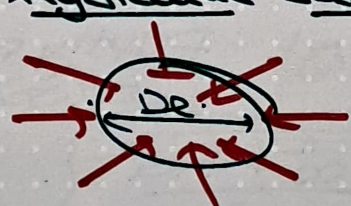
$h = \cos\left(\frac{\pi}{6}\right) \cdot p = \frac{\sqrt{3}}{2} \cdot p$

$P_w = \pi R_{co}$

$3 \times \frac{1}{6} 2\pi R_{co}$.

· **Also**: (Equivalent Hydraulic diameter def.)

$\Leftrightarrow$



$P_w = \pi D_e$.

$A = \pi \frac{D_e^2}{4}$

$\frac{A}{P_w} = \frac{D_e}{4}$

$\Rightarrow \boxed{D_e = \frac{4A}{P_w}}$.

· D_e is such that the ratio $\frac{A}{P_w}$ is the same as in the original problem!

· **Discretization**:

· Axial discretization: $\Delta z = \frac{H}{N_z}$ — height; N_z — number of axial nodes.

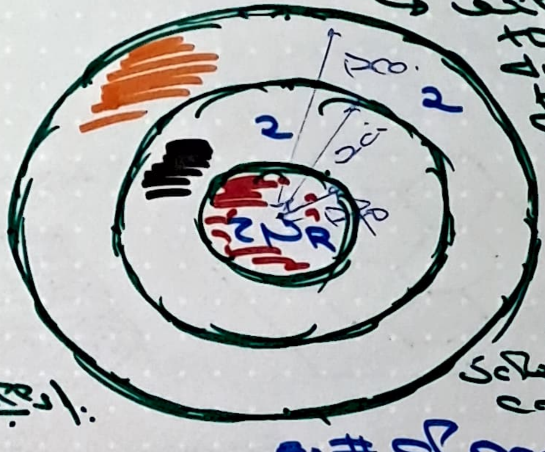
· Radial discretization: 3 tricks!

we want to define surfaces of equal area! (Equisurfaces).

Page 1.

Radial boundaries:

$N_R = 5$. total number of nodes $2N_R+4$ → diff needs to discretize the operator.



Schematically!

2: # of nodes in each section

Part: Fuel:

- For r_i, $i=1$:

$\Rightarrow \pi r_1^2 = \frac{1}{2N_R}\cdot \pi Rfo^2 \Rightarrow$

$$\Rightarrow \boxed{r_1 = \frac{1}{\sqrt{2N_R}}\cdot Rfo}$$

- For r_i, $i\geq 2$ it's different (slightly):

$$\frac{\pi Rfo^2}{2N_R} = \pi r_k^2 - \pi r_{k-1}^2 \quad , k\geq 2$$

$$\Rightarrow \boxed{r_k = \sqrt{\frac{Rfo^2}{2N_R} + r_{k-1}^2}} \quad k\geq 2.$$

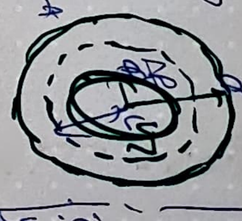
Schematically:

= equisurfaces

Part Gap:

Area: $\frac{\pi Rci^2 - \pi Rfo^2}{2} = \pi r^2 - \pi Rfo^2$

Schematically:



$$\Rightarrow \boxed{r_g = \sqrt{\frac{Rci^2 + Rfo^2}{2}}}$$

→ point "mid-way" through the gap: r_g.

As in: so as to define equidistant surfaces.

Part Cladding: Pretty much same as gap derivation.

$$\boxed{r_c = \sqrt{\frac{Rco^2 + Rci^2}{2}}}$$

→ point "mid-way" through cladding.

Final required definitions:

- DR → size of the radial nodes (easily obtained from the radial boundaries).
  - ↳ $r_{i+1} - r_i$ ...
  - ↳ r_{fi}: Discretization points
- SR → Perimeters: $2\pi r$
- SR → Surfaces: πr_1^2; ...
  - $\pi r_{i+1}^2 - \pi r_i^2$. (Shell).

Pretty obvious definitions... follows from what we've seen before.

Verifying the value of this allows us to confirm that our equisurfaces were correctly defined and computed.