Exercise 1

Figure 1 below presents a schematic of a 4-poles permanent magnet machine. The air gap of the machine is δ=1 mm and its middle surface radius is 10 mm. we want to have a flux density of B_δ =1 T in the air gap.

Assume the flux is only radial and ignore the permeability of the iron and the leakage. Use the red line as a flux path. The magnet can be assumed linear with B_r=1.2 T and H_c=-900 kA/m. Assume the surface area of the PM and the air gap at the middle of their corresponding rings.

a. Calculate the needed height of the permanent magnets.
b. Calculate the volume of permanent magnets if the machine axial length is 300 mm

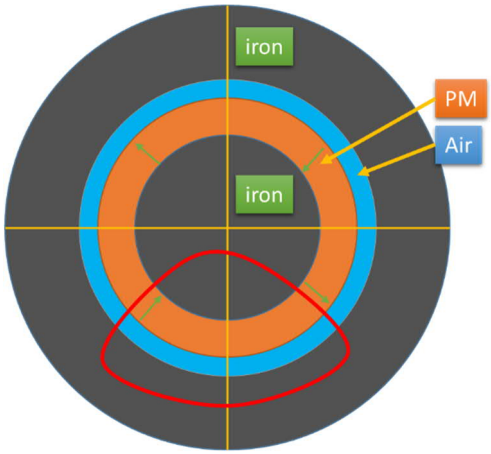

Figure1. Schematic representation of an electrical motor with radially magnetized permanent magnets.

Exercise 2

The magnetostrictive actuator in Figure 2 below has a magnetostrictive rod as active part. A spring is used to pre-stress the active rod and a coil is used to magnetize the rod. The iron core permeability can be assumed infinite. The magnetostrictive rod characteristics are given in the Table 1 below in terms of magnetostriction as function of magnetic flux density and and magnetic flux density as function of magnetic field strength, both under different compressive stresses. The actuator is designed to produce 100 um stroke and the rod has an effective length of 100 mm.

a) Calculate the needed pre-stress so that the magnetic field strength is minimum at 100 um.
b) Assume no air gap in the magnetic circuit, which effective length is 300 mm and calculate the Ampere-turns needed to produce the maximum stroke of 100 um.

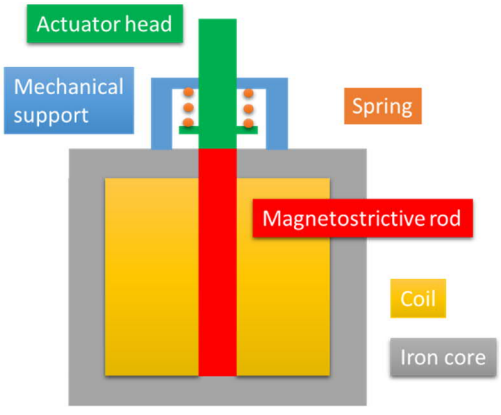

Figure 2. Schematic representation of a magnetostrictive actuator with pre-stressed rod.

Table 1. Material properties of the magnetostrictive rod . Lambda is the relative magnetostriction ΔL/L. The same characteristics are plotted in the figures below.

-60MPa				-20MPa				0MPa		
H (kA/m)	B(T)	Lambda (um/m)		H (kA/m)	B(T)	Lambda (um/m)		H (kA/m)	B(T)	Lambda (um/m)
0,00	0	0		0,00	0	0		0,00	0	0
0,16	0,152	100		0,16	0,222	250		0,16	0,352	700
0,32	0,324	300		0,32	0,454	900		0,32	0,654	920
0,48	0,486	1100		0,48	0,606	1300		0,48	0,786	980
0,64	0,608	1500		0,64	0,688	1400		0,64	0,808	995
0,80	0,71	1600		0,80	0,76	1400		0,80	0,81	1000