# Microwave Magnetics
## Homework assignment 4

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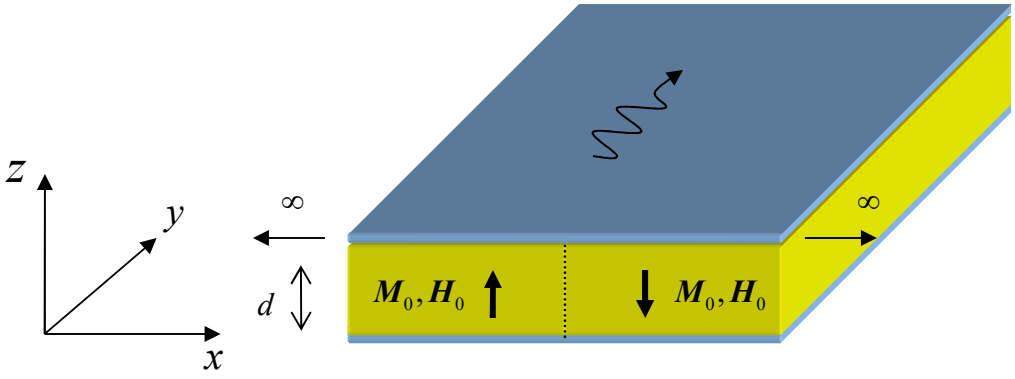
**Problem 1:**

The region between two infinitely extended, perfectly conducting parallel plates is filled by two half-infinite magnetic slabs as in the figure below. The magnetic slabs have a saturation magnetization of $M_s$. But the left slab is magnetized along the $+z$ direction while the right slab is magnetized along the $-z$ direction by internal dc fields of $+H_0$, respectively, $-H_0$ as shown in the figure below. The relative dielectric constant of the slabs is $\varepsilon$, and they have a thickness of $d$. Losses in the magnetic material and variation of the field in the vertical ($z$) direction inside the magnetic slabs are neglected.

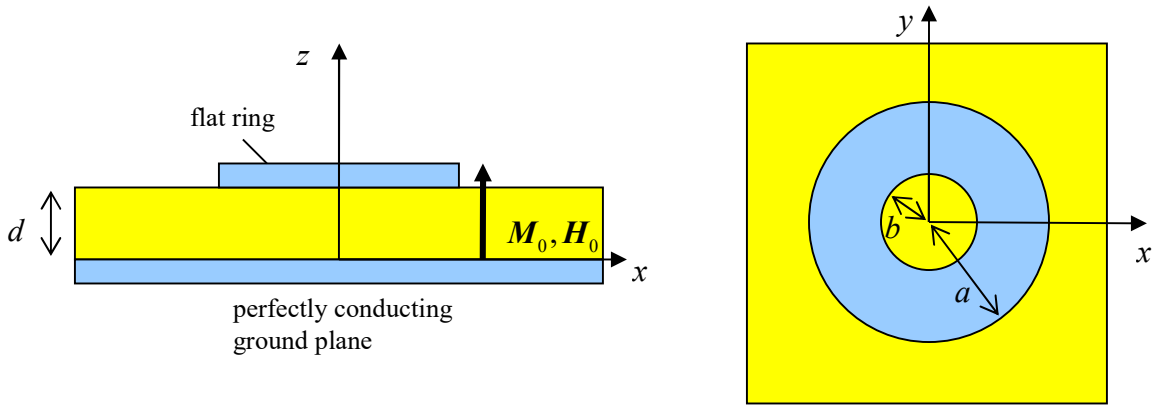
(i) Does this structure have modes guided along $y$? If so what is their dispersion relation?

(ii) In which frequency range do these modes propagate?




**Problem 2:**

Consider a grounded, lossless magnetic substrate with a thickness $d$ which has a saturation magnetization of $M_s$ and is magnetized along the $+z$ direction by an internal dc field of $H_0$ as shown in the figure below. The substrate has a relative dielectric constant of $\varepsilon$. A perfectly conducting, circular ring with an inner radius of $b$ and outer radius of $a$ is placed on top of the substrate. Under the ring, in the magnetic substrate, we neglect the variation of the field in the vertical ($z$) direction. Now assume that the inner boundary circle of the ring is connected to sources which impose an electric field $\mathrm{e}_z(b,\varphi) = f(\varphi)$ where $0 < \varphi < 2\pi$. Using suitable boundary conditions find the electric field on the outer boundary ($r = a$) of the ring.




**Problem 3:**

Consider the microstrip device shown in the figure below. It consists of a microstrip with the width *a* built on top of a finite magnetic substrate such that the right edge of the microstrip floats above the ground plane by an amount equal to *g*. The magnetic substrate is insulating and lossless, and is magnetized in the vertical direction with the saturation magnetization $M_s$ under a dc bias field of $H_0$. Its thickness is $t$ and its relative dielectric constant is $\varepsilon$. We are interested in solutions of the type

$$\mathbf{e}(x,y) = \mathbf{e}(x)\exp(-j\beta y), \quad \mathbf{h}(x,y) = \mathbf{h}(x)\exp(-j\beta y)$$

in which the electromagnetic field is uniform in the z-direction and propagates along the microstrip (y-direction) with a propagation constant $\beta$. We confine ourselves to solutions where the electric field is parallel to the z-axis. Assume that $a, g >> t$.

1. Use magnetic wall boundary conditions and find an equation for $\beta$.

2. Are there any solutions without a cutoff frequency similar to the edge guided modes of a microstrip above a grounded magnetic substrate?