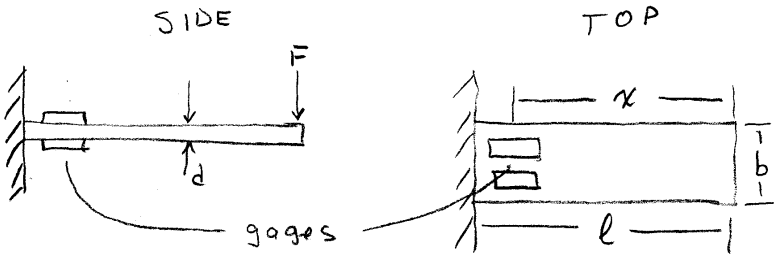
ELEC 435
Problem Set 10
Due: November 14, 2014

Homework Problems.

H10.1 The device shown below is a bending beam force sensor, consisting of a steel beam ($E = 2 \times 10^{11}\mathrm{N/m^2}$) with four strain gages ($K = 2$) attached as shown. The dimensions are: $l = 50$ mm, $x = 40$ mm, $b = 10$ mm, $d = 2$ mm. The gages are connected in a full bridge configuration, with an excitation of 9 V. What is the sensitivity (in V/N) for this device?

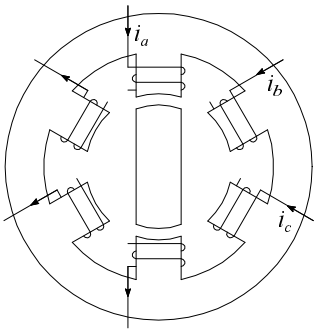
Hint: For a cantilever beam, a force F at the free end produces a surface stress of $\dfrac{6Fx}{bd^2}$ at a distance x from the free end.



H10.2 The 3-phase variable reluctance stepper motor shown in the figure has a T vs. Θ relationship which is sinusoidal.

(a) If I is the magnitude of the rated current per phase for single step operation, what should be the sequence of current values for half-step operation to give the same value of peak holding torque? For quarter-step operation?

(b) Determine the half- and quarter-step current sequences for a stepper motor having the same stator configuration, but with a smooth cylindrical permanent magnet rotor.



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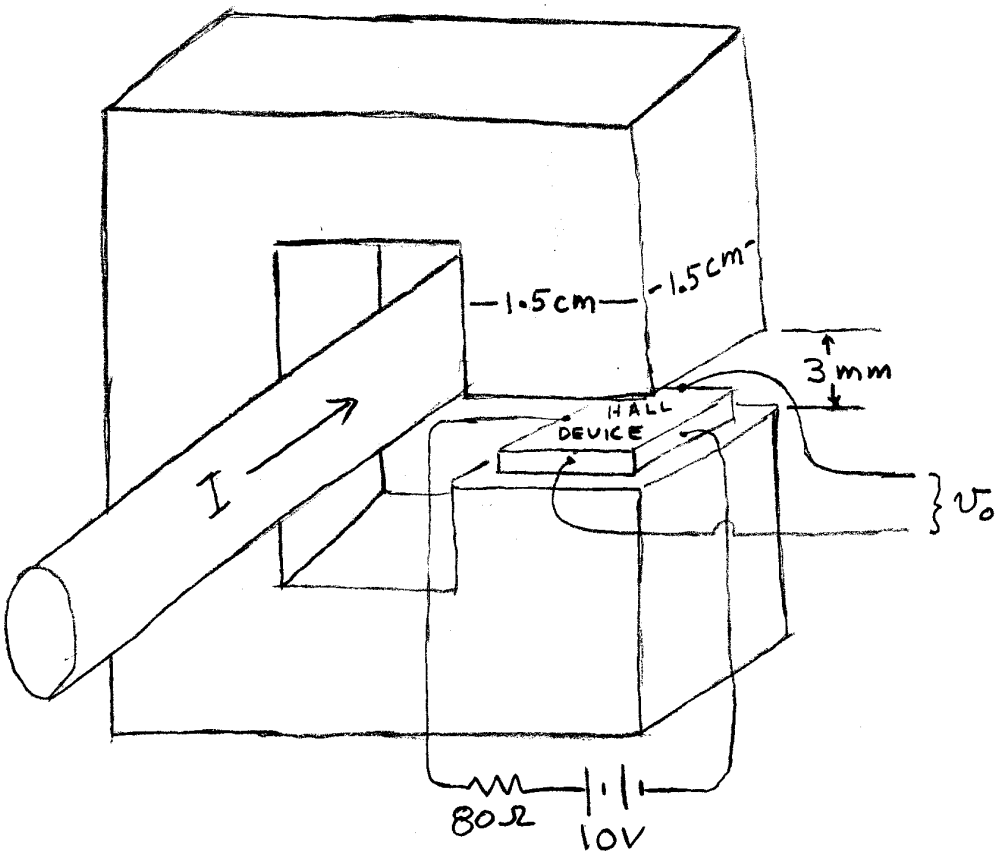
H10.3 The device below is used for measuring current in situations where it is undesirable to break the conductor and insert a current sensing resistor. The Hall device is 1 cm square and 0.5 mm thick and is made of germanium, which has a Hall coefficient of $4.0 \times 10^{-3}\mathrm{m}^3/\mathrm{C}$ and a resistivity of 0.01 Ωm. The core is made of iron, with a relative permiability of 5000 and a saturation flux density of 2.0 T, and has an effective length of 15 cm.

(a) What is the sensitivity (v_o/I)of this device?

(b) What is its range?



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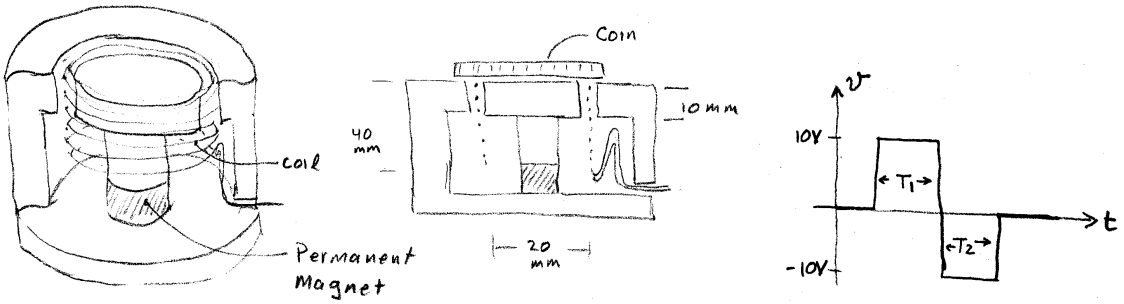
Quiz Problems.
None this week.

Project Problems.
This problem is due on November 22.

P10.1 Simulation Project.

The contraption below is an electric coin tosser, made from the innards of a recycled loudspeaker. The coil is a single, closely wound layer of 30 ga copper wire, 40 mm long and 20 mm in diameter. The coil is placed in a cylindrical gap which is 1 mm wide, 10 mm long, and has a radial magnetic flux density of 0.5 T.



A coin is tossed by applying a short 10 V pulse to the coil. To prevent the coil from being tossed along with the coin, this pulse is immediately followed by a -10 V pulse to decelerate the coil and return it to its starting position. The composite tossing pulse is shown in the plot below. The coin being tossed is a US Quarter Dollar.

Your task for this project is to simulate the behavior of this system, using Matlab, Simulink, or other appropriate environment. Your simulation should be as comprehensive as possible and should incorporate all of the information given above. Be sure to state and justify any additional assumptions that you make. Provide a justification for each numerical parameter in your simulation. Demonstrate your simulation with appropriate plots. Be sure to include a printout of your program with your writeup.

When your simulation is working to your satisfaction, use it to answer the following questions:

(a) If T_1=10 ms, how high will the coin be tossed?

(b) How wide should the -10 V portion of the pulse (T_2) be to return the coil to its starting position?