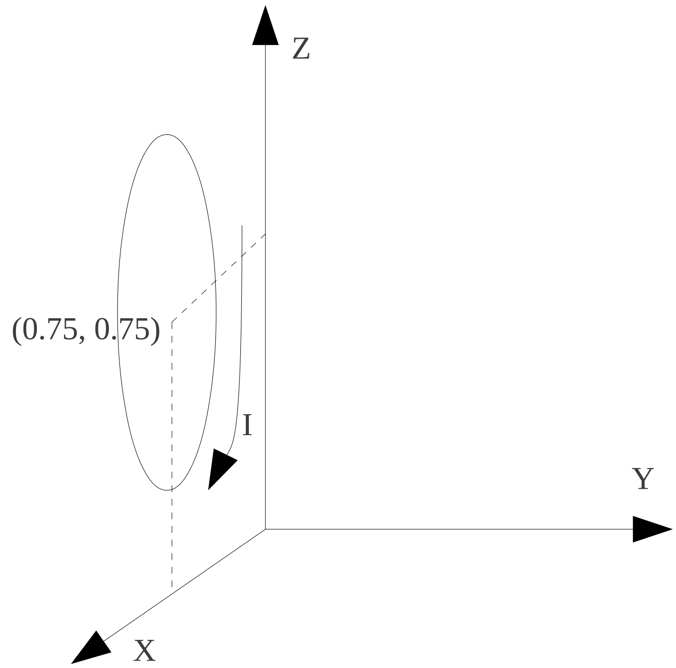
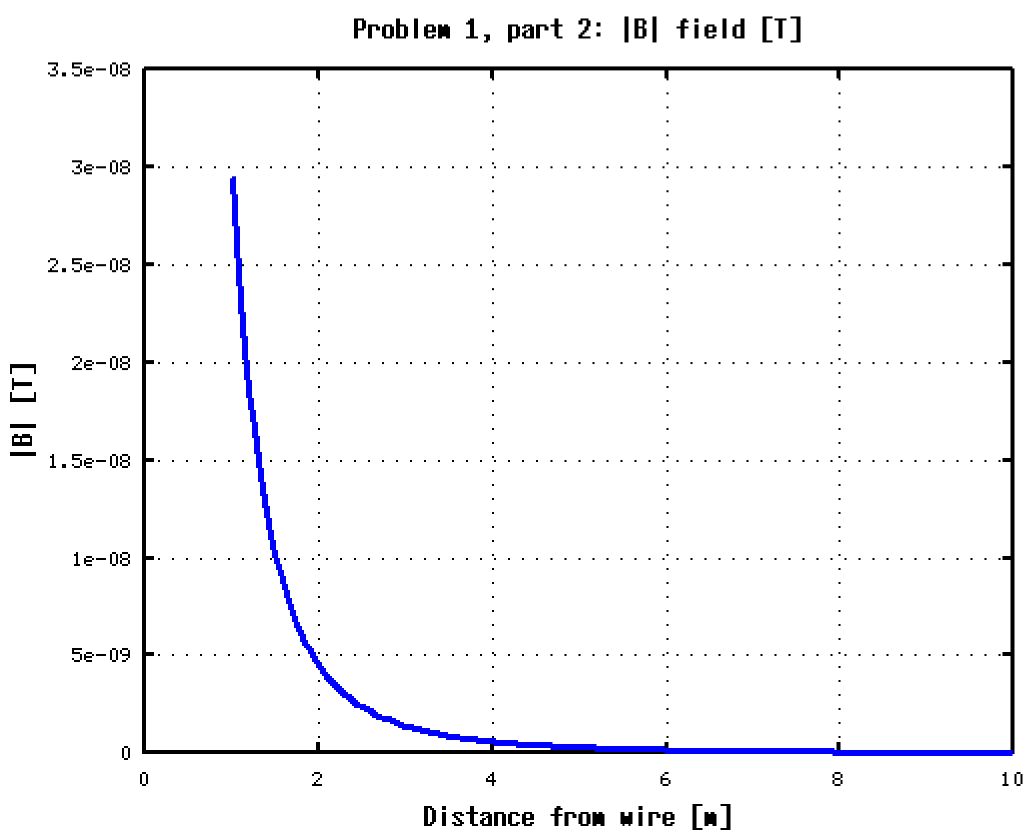
Homework #2 - Answer Key
C.J. Cela, Spring 2012

Problem 1)

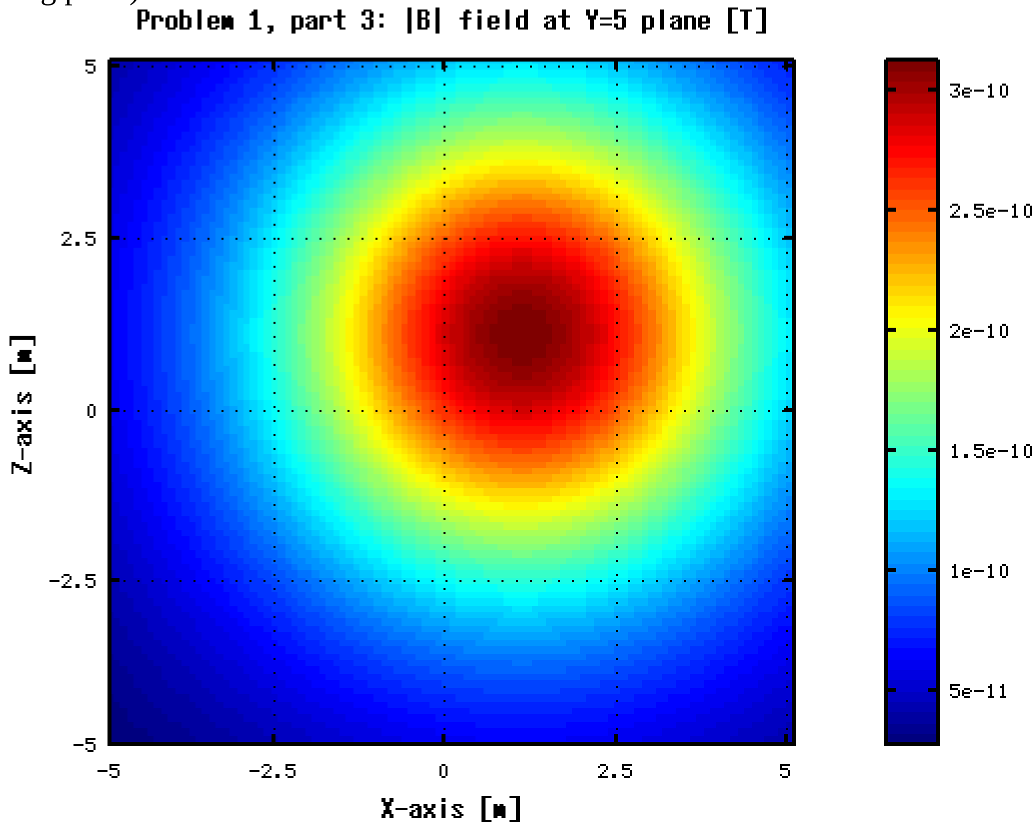
1)



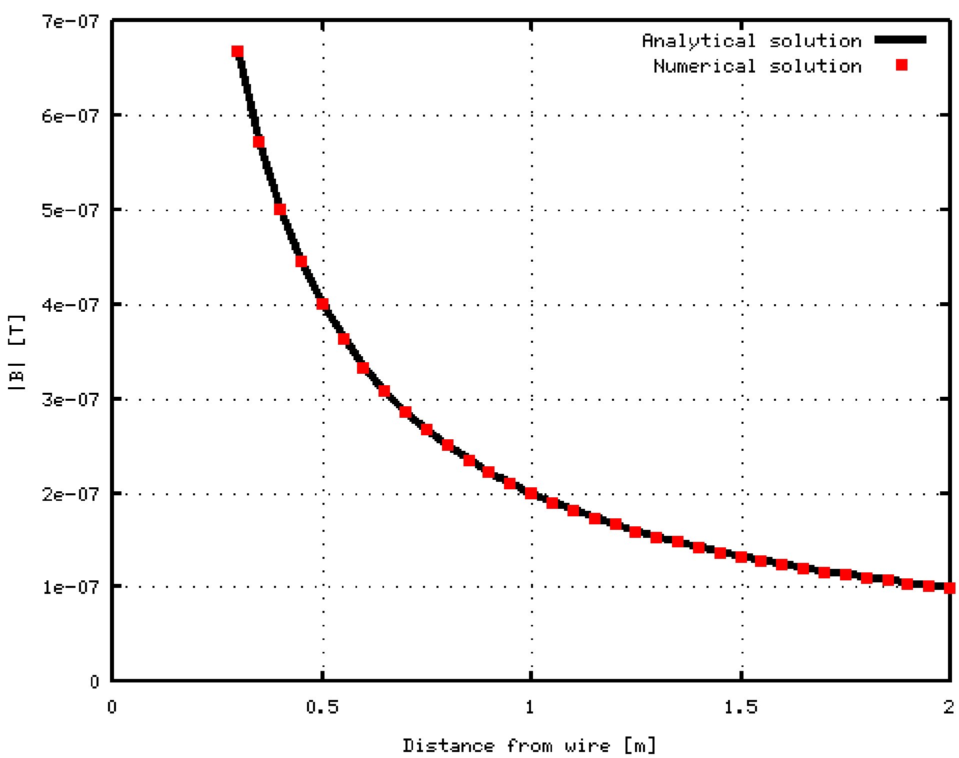
2) (Solved using p1.m)



3) (Solved using p1.m)



(optional) Code verification was done by solving the field generated by current circulating through a long wire analytically, and comparing it with the numerical solution (using verification.m). Plot below shows result:



Problem 2:

1)

FROM GAUSS,

$$(1)\quad \oint_S \bar{E}\cdot\hat{n}\,ds = \frac{Q}{\varepsilon_0}$$

SINCE $Q = \rho\,\Delta V$, AND $\Delta V = \int_V dv$

$$(2)\quad Q = \int_V \rho\,dv$$

FROM (1) AND (2)

$$(3)\quad \oint_S \bar{E}\cdot\hat{n}\,ds = \frac{1}{\varepsilon_0}\int_V \rho\,dv$$

FROM THE DIVERGENCE THEOREM,

$$(4)\quad \oint_S \bar{E}\cdot\hat{n}\,ds = \int_V \nabla\cdot\bar{E}\,dv$$

THEN, FROM (3) AND (4),

$$\int_V \nabla\cdot\bar{E}\,dv = \frac{1}{\varepsilon_0}\int_V \rho\,dv$$

AND SINCE THE INTEGRANDS ARE EQUAL,

$$\boxed{\nabla\cdot\bar{E} = \frac{\rho}{\varepsilon_0}}$$

2) The total net magnetic flux through ANY closed surface is zero. If the surface is not closed (i.e. a cube without a face), the net flux can be positive, negative, or zero.

3) Because there is no magnetic monopole. Then, the magnetic lines are not generated at a point, but instead always close on themselves. This makes the divergence of a B field to be zero at any point.

4) Circulation of a vector field over a curve is the line integral over that curve of the tangential component (respect to the curve) of the vector field. The curve must be closed in order for us to call it 'circulation'. In physical terms, the circulation represents the work done by the vector field on the interacting particle (i.e. electric charge in the case of electromagnetics), measured in Joules.

5) The vector field is path-independent, or 'conservative'. This also means that for the integral of the tangent component of the field to any arbitrary curve (may be open), the value of the integral will not depend on the path of integration, only on the initial and final points of said path.