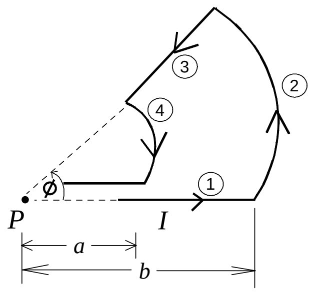
Engineering 6813 Assignment 2 **Due: Mon., Sept. 28, 2009**

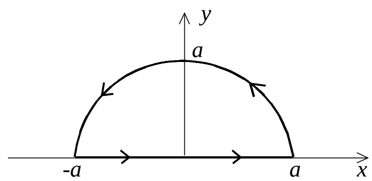
1. A current carrying loop consisting of radial lines and circular arcs has the the geometry shown. Use the Biot-Savart law to determine the magnetic field at P due to the loop current I in segments 1, 2, 3, and 4. Give your answer in terms I, a, b and ϕ.



2. An infinitely long, thin conducting sheet defined over the space $0 \leq y \leq w$ and $-\infty \leq x \leq \infty$ is carrying a current with a uniform surface current density of $\vec{K} = \hat{x}\,5$ A/m. Use the Biot-Savart law, to obtain an expression for the magnetic field intensity $\vec{H}$ at the point $P(0, 0, z)$ in Cartesian coordinates.

3. Verify Stokes' theorem over the semicircular contour shown below for the magnetic flux density

$$\vec{B} = \hat{\rho}\rho\cos\phi + \hat{\phi}\sin\phi \ .$$



4. A long cylindrical conductor of radius a is centred on the z-axis. The conductor carries a current density $\vec{J} = \hat{z}J_0/\rho$ where J_0 is a constant (in units of A/m^2) and ρ is the usual cylindical coordinate. Use Ampère's law to determine $\vec{H}$ inside and outside the conductor.

5. A uniform current density given by

$$\vec{J} = \hat{z}J_0 \text{ A/m}$$

gives rise to a vector potential

$$\vec{A} = -\hat{z}\frac{\mu_0 J_0}{4}\left(x^2 + y^2\right) \text{ Wb/m} \ .$$

(a) Apply Poisson's equation to confirm the above statement.
(b) Use $\vec{A}$ to find $\vec{H}$.
(c) Use the expression for $\vec{J}$ and Ampère's law to find $\vec{H}$ and compare with the result in part (b).

6. A particular power transmission line carries 1000 A in opposite directions in each of its long parallel conductors strung on poles 100 m apart. If the radius of each conductor is 2 cm and the separation between their axes is 1 m, determine the total flux passing through the rectangular region bounded by the conductors and two consecutive poles. See diagram below.