EML 5060 **Analysis in Mechanical Engineering** **9/19/03**
Closed book *Van Dommelen* *9:15-10:05 pm*

Show *all* reasoning and intermediate results leading to your answer, or credit will be lost. "My calculator says so" is not acceptable. One book of mathematical tables, such as Schaum's Mathematical Handbook, may be used, as well as a calculator, and a single *handwritten* letter-size formula sheet.

1. The contour of a wall in an inviscid flow satisfies the equation

$$x = \arctan\left(\frac{x}{y}\right).$$

   This can be solved for y as

$$y = \frac{x}{\tan x}.$$

   Be careful though, the only occurring values for the arctan in the first expression are those in between $-\pi$ and $+\pi$. Find the extends, intercepts, asymptotes, maxima and minima, and symmetries of this curve and based on those, draw the curve as accurately as possible.

2. A flat solar power panel works best if it is directed towards the sun. Use an x, y, z-coordinate system with the y-axis along the ground pointing north, the x-axis pointing east, and the z-axis straight up. Assume that the sun is in the northeast, and at an inclination angle of 45 degrees above the ground. Also that the center of the solar panel is 5 meter above the ground on the z-axis. Find the equation for the plane of the solar panel in terms of the given coordinate system.

3. If the dimensional errors in a batch of manufactured parts follow a normal probability distribution, then the amount of parts that exceed the acceptable tolerance can be computed using the so called error function $\mathrm{erf}(x)$. This function is defined as

$$\mathrm{erf}(x) \equiv \frac{2}{\sqrt{\pi}} \int_{\xi=0}^{x} e^{-\xi^2} \mathrm{d}\xi$$

   Use a Taylor series to evaluate $\mathrm{erf}(0.5)$ to an error of less than 0.001 using only the following keys on your calculator: $+ - * / \sqrt{} x^y \pi$. Do not evaluate more terms than needed.