CO 417 Spring 2013 Homework 2
http://www.doc.ic.ac.uk/~ghosh/CO417-HW2.pdf

due Mon Feb 25, 2013, 2pm

- **Part 1: Generate plots of Fresnel reflectance**
  - Write your own code (e.g., in GNUPlot or MATLAB) to generate plots of Fresnel reflectance for a dielectric material. Choose the index of refraction of the material eta_t=1.5 and plot out reflectance values (Y-axis) for incidence angles ranging from 0 – 90 degrees of incidence (X-axis). Plot curves for both the parallel and perpendicular polarized components. Report the reflectance of both components at normal incidence ($\theta = 0$ degrees) and the Brewster's angle for such an air-material interface.
  - Do the same for a ray exiting the material into air (eta = 1.0). Report the critical angle for such a material.

- **Part 2: Generate samples according to an Environment Map**
  - Write your own code to load the Grace Cathedral environment map in latitude-longitude format and generate samples according to the 2D CDF of the EM. Note that you should create the CDF based on the intensity (luminance) of each pixel **I = (R+G+B)/3**. And the intensity of each pixel needs to be scaled by the solid angle term **sin(θ)** where the latlong map varies from the top to bottom $\theta = 0$ – PI.
  - Write out the EM (.pfm) with the pixels corresponding to the chosen sample directions set to green. For illustration, you should really set a 5x5 or 9x9 neighborhood around the chosen pixel to green (0,1,0).
  - Do this for 64, 256 and 1024 samples and save the output (.pfm) as LDR images (.ppm) with appropriate gamma correction.

- **Part3: Generate samples according to a Phong BRDF**
  - Choose a principle direction (e.g., north pole) on the EM and generate samples according to Phong BRDFs of exponent s=1.0, 10.0, 50.0, 200.0 about this principal direction. This assumes that the local surface normal of the BRDF is aligned with the global +Y (north pole) of the EM.
  - Save output as both .pfm and as LDR .ppm images with the chosen pixels set to green similar to part 2.

- **Part 4: Render a sphere with sampled Environment Map**
  - Write your own code to render a sphere with the 64, 256 & 1024 samples drawn from the Grace Cathedral EM in part 2. Assume a diffuse BRDF with ρ_d =1.0. Sum up the contributions of the samples according to MC importance sampling equation for EM sampling discussed in class. Note that this is similar to ray-tracing except that you do not need to trace any rays as visibility $V(x, \omega_i) = 1$. Assume an orthographic camera with view vector $\omega_o = (0,0,1)$. Set the rendered image resolution to 511x511. Then every pixel inside the projected circle of the sphere corresponds to a different direction (surface normal) similar to HW1.
  - Since the sampling from EM will be done based on the luminance channel, you will have to multiply the BRDF by a **normalized RGB color** of the sampled light source direction. Will discuss this in class!
  - Note that in a typical Monte Carlo renderer, you will have to draw new random samples for every pixel in your image. For this assignment, you can use just one set of drawn samples from the EM for rendering the entire sphere. This means that your image will **not** have the typical Monte Carlo variance (noise)! However, with increasing number of samples, the rendered image should converge more towards the correct solution.
  - Save the rendered images as both .pfm and as LDR .ppm images with appropriate gamma setting.

- Prepare homework as a WORD or PDF document, and include all images (.ppm) and plots generated for the assignment. Submit the document and all images (.pfm and .ppm) on CATE as a zip file.