M.S. Comprehensive Exam Spring 2013 – Photonics (ECE240A/B/C)

Problem 1:

Two planewave beams interfere in a thick material to record a hologram. One beam enters the material at 20° above the material surface normal, the other enters at 40° below the surface normal. The freespace wavelength of the light is 0.5 microns. The index of refraction of the material is 2.0.

a) What is the period of the grating formed?
b) What is the angle between the surface normal and the grating fringes.

Problem 2:

An acoustic optical modulator is driven with a 1 GHz signal. The acoustic velocity in the material is 1000 m/s.

a) What is the period of the grating that is formed?
b) If the modulator is operating in the Raman-Nath regime, and light with $\lambda = 0.5$ μm is normally (perpendicular) incident on the surface, what angles do the first and second order diffracted beams make with the surface normal
c) The ratio of the optical frequency of the second order diffracted beam to the optical frequency of the input beam is what?

Problem 3:

The manufacturer of LCD panels wants to use coherent optical filtering for quality inspection. The panels have the repeated display cell pattern shown at bottom, but occasionally, irregular dirt, dust, or defects occur, which is also shown. The idea is to prepare an optical filter that will block the regular pattern of a good display, but pass an image of the defects to the output plane.

a) Sketch the overall optical system that could be used for such filtering. Indicate the input, filter, and output planes, and the relative distances of other components.
b) Sketch a face-on view of the filter plane transparency that could be used. Indicate which portions of the filter block which features of the display.
c) The manufacturer would like to know where the defects are on the display so he can use an air jet to try to blow them off. Does the filtering system support this or not? If so, how? If not, why not?