(1) A point source of light that emits 1W of light at 500nm is placed on axis 100mm from the end face of a single mode fiber with core diameter 4µm, \( n_1 = 1.5 \), \( n_2 = 1.48 \). Calculate:

(a) The N.A. of the fiber.

(b) Is the fiber single mode at this wavelength?

(c) If the fiber is not single mode, what wavelength would be needed to ensure this?

(d) Use a simple ray model to calculate the power that is guided in the fiber.

(2) A prism can be used to deflect the angle of a laser beam. For a prism of apex angle \( A \) calculate the minimum angular beam deviation that can be produced. The index of refraction of the prism is \( n \). The analytical result can be discovered by plotting the deviation for different values of \( A \) and \( n \).

(3) A photomultiplier (PMT) has a dark noise level of 100 pulses per second. Calculate the minimum optical power (S/N=1) at 500nm that can be detected with a 10 second integration time. Assume that the quantum efficiency of the PMT is 0.2 at 500nm.

(4) A p-i-n photodiode has responsivity 0.8A/W at 1.3µm. The effective resistance of the detector circuit is 50ohm. The photodiode dark current is 1pA/√Hz. Calculate the NEP at 300K of the detector. Include both shot noise and Johnson noise in your calculation. If the area of the detector is 1mm\(^2\) what is its detectivity?

(5) How would the answer to question (5) be modified if the detector were feeding an amplifier with a noise temperature of 600K?

(6) Use the World Wide Web to find a photodetector that provides performance better than 1 GHz at 1.55µm. Print out the data sheet and identify responsivity, quantum efficiency, detector time constant, dark current and NEP.