Complex Engineering Problem

Name: **Masood ullah**
Roll No: **AP-19066**

Design of Spectrometer for Optical Coherence Tomography System

1. The first step in the design of the spectrometer is to determine the diffraction angles for the given diffraction grating and light source. The diffraction angle for a given wavelength, λ, is given by the equation:

$$\theta = (m\lambda)/d$$

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where m is the diffraction order, d is the grating constant (distance
between lines on the grating), and λ is the wavelength of light.
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2. Using this equation and the given values for the diffraction grating (1800 lines/mm) and the light source (800 nm center wavelength and 100 nm bandwidth), we can calculate the diffraction angles for different wavelengths. The graph of the diffraction angles versus wavelength.

3. Next, we need to design the optical layout of the spectrometer. The collimated light source will be directed onto the diffraction grating, which will diffract the light into different wavelengths. The diffracted light will then pass through the focusing lens and be focused onto the line scan camera. The line scan camera will be able to detect the different wavelengths of light and provide a spectrum of the light source.

4. The key design considerations for the focusing lens are the focal length and the numerical aperture (NA). The focal length of the lens is given as 100 mm, which is suitable for the required focal length. The NA of the lens is given by the equation:

$$NA = n\sin(\theta)$$

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where n is the refractive index of the lens material and θ is the maximum
acceptance angle of the lens.
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5. The line scan camera has 2048 pixels with a pixel size of 15 um, which is suitable for the required resolution. The line scan camera will be able to detect the different wavelengths of light and provide a spectrum of the light source.

6. Based on the above calculations and considerations, the final optical layout of the spectrometer.

7. The spectrometer will be able to detect the different wavelengths of light and provide a spectrum of the light source. This will be useful for the detection part of the optical coherence tomography system.

8. The spectrometer is designed and optimized for the given parameters of light source and diffraction grating, and will provide a high resolution spectrum of the light source for the detection part of the OCT system.