

EE119 Discussion Section 4

(02/22/10)

Professor: Jeff Bokor TA: Xi Luo

1. Resolution limit of optical systems – Rayleigh’s criterion

[Hecht 10.28] The Mount Palomar telescope has an objective mirror with a 508-cm diameter.

- (a) Determine its angular limit of resolution at a wavelength of 550 nm, in radians, degrees, and seconds of arc.
- (b) How far apart must two objects be on the surface of the Moon if they are to be resolvable by the Palomar telescope? The Earth-Moon distance is 3.844×10^8 m; take $\lambda = 550$ nm.

2. The Human Eye - Vision Acuity, Accommodation, Vision Correction

- 1) Your TA wants to demonstrate her accuracy with a bow and arrow. She chooses YOU to place an apple on your head and walk 200m away.
 - a) If the radius of the apple is about 4cm, what is the approximate diameter of the image of the apple cast on her retina?
 - b) If she tells you she can accurately hit any target that she can resolve with her eyes (assume she is not lying and she has normal vision), will she be able to hit the apple, or do you run away screaming? What about she asks you to hold a coin with 1cm in diameter instead?
- 2) Your TA is actually quite poorly near-sighted. She wears glasses that have power of -7D for her left eye, and that of -3D for her right eye. What is the farthest distance that each of her eyes can clearly focus on an object?
- 3) A patient is determined to have a near point at 50cm. Assume the eye is 2.0cm long. How much accommodation does his eye have? What power corrective lens should be used to enable the patient to focus at the comfortable reading distance of 25cm?
- 4) Looking through a small hole is a well-known method to improve sight. If your eyes are near-sighted and can focus an object 20 cm away without using glasses, estimate the required diameter of the hole through which you would have good sight for object far away. (Assume the eye is 20 mm long.)

3. Still Camera – Shutter speed, F-number, Depth of Focus

- (a) [Hecht 5.80] If a photograph of a moving merry-go around is perfectly exposed, but blurred, at $1/30$ s and $f/11$, what must the diaphragm setting be if the shutter speed is raised to $1/120$ s in order to “stop” the motion?
- (b) If the camera lens is a diffraction-limited system, what is the angular resolution with the new setting (use $\lambda = 550$ nm)?