Assigment: Flux, Magnitudes, Extinction and photometry

1. Show that intensity is independent of distance.

2. Although the amount of interstellar extinction varies considerably from place to place, we can use an average value of 2 mag/kpc near the galactic plane. Assuming that what is the distance of the star if its absolute magnitude is M = −2 and the apparent magnitude m = 8.

3. You observe a star through two different filters with the following apparent magnitudes: m_B=16.5 and m_V=15.8. Calculate the B-V color index of the star. What does the sign of this color index generally indicate about the star's temperature?

4. The altitude and magnitude of a star were measured several times during a night. The results are given in the following table. Find out the extinction coefficient k and the magnitude m_0 outside the atmosphere of earth.

Altitude (degree)	Zenith distance (degree)	Airmass	Magnitude
50	40	1.31	0.90
35	55	1.74	0.98
25	65	2.37	1.07
20	70	2.92	1.17

5. Aperture Photometry and Data Reduction:
You are given a simplified 2D array representing a small section of a CCD image around a star. The pixel values represent the detected counts. Assume the sky background is relatively uniform.

[10, 12, 15, 13, 11],
[14, 25, 55, 28, 16],
[12, 48, 180, 52, 18],
[15, 27, 60, 30, 13],
[11, 13, 16, 14, 12]

(a) Write a code to estimate the sky background level per pixel using the pixels in the corners of the image (assume a 1-pixel border from each edge represents the background). Calculate and print the average sky background.

b) Perform aperture photometry on the central star (located at index [2, 2]). Use a circular aperture with a radius of 2 pixels (including the central pixel). Write a code to sum the counts within this aperture.

c) Subtract the estimated sky background from the total counts within the aperture. Remember to account for the number of pixels in your aperture. Print the background-subtracted counts.

d) Imagine you have another star in the same image with background-subtracted counts of 5000. If the star you analyzed in parts (b) and (c) has a known apparent magnitude of 14.2 in this filter, write a code to estimate the apparent magnitude of the second star using the ratio of their fluxes.

6. You are given two lists representing time (in days) and the corresponding apparent magnitudes of a variable star:

time = [1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0]
magnitude = [15.1, 15.8, 15.2, 14.5, 15.1, 15.7, 15.3, 14.6, 15.0, 15.8, 15.1]

a) Write a code to generate a scatter plot of magnitude versus time. Label your axes appropriately.

b) By visually inspecting the plot, estimate the approximate period of the variable star in days. Explain your reasoning.

c) Write code to attempt a more precise period determination. You could try techniques like finding the time difference between consecutive minima or maxima.