Problem 1.

Consider ground based photometric observations of a star, gas and hot dust using a narrow band in the near IR at 2.40 microns (at the edge of standard K band).
Besides other effects, take into account the presence of DIB (diffuse interstellar bands) in that wavelength region.

The two dimensional detector used is non-linear and present a thermal noise comparable to the photon background. Consider a constant zero bias level. .

Taking into account a source count rate lower than the background (photon+thermal)
(l) discuss and analyze the additive, multiplicative and scaling factors on the raw count rate for the star (point source - i. e. integrated raw counts over a circular region in the detector with radius given by the image quality in the K band).
(2) discuss and analyze the factors above or a measurement of the surface brightness (mag/arcsec^2) of the surrounding extended region in the same narrow band.

Problem 2.

The origin of noise in a two-dimensional detector are identified as: sky background counts, detector and amplifier readout noise, detector thermal counts, and photon counting statistics.

Find the relations between the integration time (E) on a point source needed in order to achieve a given Signal-to-noise ratio (S/N).
Use arbitrary scaling constants due to detector quantum efficiency and telescope/instrument transmission and plate scale.

The independent variables in those relations may be:

1. source integrated flux inside the PSF (F),
2. telescope aperture (D),
3. readout noise per pixel (RON),
4. sky background flux per pixel (S),
5. image quality FWZI in arcsec (W).

Consider the following cases:

i. A faint target, when compared to the sky background. The target+sky count level is much larger than the RMS readout noise (RON).

ii. A faint target, when compared to the sky background. The target+sky count level is below or comparable to the RMS readout noise (RON).

iii. same as (ii) with diffraction limited image quality (W α 1/D).

Problem 3.

Consider the broadband photometry of a UV/blue bright object in the U and B Johnson bands.

Red standard stars are used for both extinction and calibration to the standard UBV system.

Show and discuss the source of significant color terms in:

- the extinction correction (second order coefficient k”_BV)

- the transformation to the standard system (mu).

Add hypothetical diagnostic graphs to your analysis.