Exposure Time Estimator

Write a program to estimate exposure time for an arbitrary observation at an arbitrary telescope. You may use the programming language of your choice. The deliverables for this assignment are a description of the algorithm and equations that you used, and the time estimates for the sample observations listed below.

Assumptions:

V-Band Observation, delta lambda for the V-band is 900 Angstroms
Extractions will be over a uniform circular aperture
F(0)= 1000 photons/sec/cm²/Angstrom at the entrance to the telescope
Entire integration occurs at Zenith

Inputs:

Sky surface brightness ( in Mag/arcsec²)
Star brightness, or surface brightness of extended source
Seeing disk diameter
Detector Parameters: pixel size, dark current, readnoise, QE (assume all are constant with lambda)
Telescope parameters: Aperture area, F/#, throughput

Evaluate the exposure time for the following situations:

a) telescope aperture: \( d_{tel} = 8m \)
\( F/#=2.77 \)
quantum efficiency \( q = 0.65 \)
Star magnitude (V-band) = 29.8
sky brightness of B = 22.5 mag/arcsec²
seeing disk diameter of \( d^* = 0.5 \) arcsec.
signal/noise = 3
Dark current = 3 e-/hour
Readnoise= 5 e-/read
Pixel size=27 µm on a side

b) same as a) except that seeing disk diameter is \( 0.2 \) arcsec, pixel size = 11 µm on a side

c) same as a) except that seeing disk diameter is \( 3.4 \) mille-arcsec (0.0034 arcsec, Diffraction limited), \( d_{tel} = 30m \), pixel size =4 µm on a side

d) same as a) except the source is extended and has a brightness of \( 25 \) mag/arcsec², calculate the exposure time for an area of 4 x 4 pixels
e) same as a) except, except the aperture is 4 m and the F/# 1.38, the source is extended and has a brightness of $25 \text{ mag/arcsec}^2$, calculate the exposure time for an area of 4 x 4 pixels.

f) same as a) except the source is extended and has a brightness of $25 \text{ mag/arcsec}^2$ and the seeing disk diameter is $0.2 \text{ arcsec}$, calculate the exposure time for an area of 4 x 4 pixels.

g) same as a) except, except the aperture is 2.4 m, the sky brightness is $B = 30.5$.

h) same as a) except, except the aperture is 2.4 m, the sky brightness is $B = 30.5 \text{ mag/arcsec}^2$ the source is extended and has a brightness of $25 \text{ mag/arcsec}^2$, calculate the exposure time for an area of 4 x 4 pixels.

i) for a), b) and g) above, plot the exposure time required for the a range of point sources with V from 16 to 28. (like figure 4 on the handout)