As usual, the honor system applies: You can discuss the problems among yourselves, how to go about them, but not derive the solutions jointly – everyone should work out their own solutions.

**Problem 1** [10 points total]:
Consider a spiral galaxy with the disk central surface brightness in the V band of $\mu_V = 21.5$ mag arcsec$^{-2}$ at the distance of the Virgo cluster, i.e., $D = 16$ Mpc. Recall that the Solar absolute magnitude is $M_V = 4.8$ mag.

a. Convert this surface brightness to the physical units of Solar luminosities per pc$^2$. Hint: get the luminosity of a 1 arcsec$^2$ patch first, then convert arcsec to pc. [6 points]

b. Assuming that the galaxy has a pure exponential surface brightness profile with the observed scale length of 30 arcsec, compute the total luminosity of its exponential disk. [4 points]

**Problem 2** [10 points total]:
Assume that the Milky Way has a perfectly flat rotation curve with $V_{rot} = 220$ km/s, and that we are at $R = 8$ kpc from the Galactic center.

a. Compute the total mass enclosed within this radius. [3 points]

b. Compute the local density of the dark halo, in g/cm$^3$ and in $M_\odot$/pc$^3$ (you can ignore the mass contribution of the visible material). [5 points]

c. If the dark matter is made out of WIMPs with a mass of 100 GeV, what is their number density per cm$^3$? [2 points]