1 Advanced Graphics (RKM)

(a) Answer the questions below, referring to the contrast-versus-intensity function in the plot shown below when appropriate.

(i) Why is luminance usually plotted using the logarithmic scale? [2 marks]

(ii) Why are stars visible at night but not in the day-time? Justify your answer referring to the contrast-versus-intensity plot above. [3 marks]

(iii) Is the sensitivity of the visual system higher when it operates in a bright environment or in a dim environment? Explain why. [3 marks]

(iv) Why is the power of 1/3 function used in CIE Lab and CIE Luv colour spaces? [2 marks]

(b) You are given a gray-scale high dynamic range image $I$ represented in absolute luminance units of $\text{cd/m}^2$. The image is to be viewed on a target display with the peak luminance $L_{\text{peak}} = 100\text{cd/m}^2$ and the black level $L_{\text{black}} = 1\text{cd/m}^2$ (both values measured in the dark environment). The display is viewed in a bright environment and the amount of the light reflected from the screen was measured to be $L_{\text{refl}} = 2\text{cd/m}^2$.

(i) Calculate the effective dynamic range (contrast) of that display in the bright environment and express it as a contrast ratio $N:1$. Show the formula as well as the final answer. [2 marks]
(ii) What operation needs to be performed on the image $I$ to make it twice as bright? Express the final result as luminance. [2 marks]

(iii) How can the contrast of image $I$ be reduced by a factor of 2 so that the luminance values equal to $L_{\text{peak}}$ do not change? Express the final result as luminance. [3 marks]

(iv) Write pseudo-code that adds glare to image $I$. The glare is modelled as a point spread function $g$. Your formula must exclude the glare that is naturally produced in the eye when viewing the target display described above. Use the $*$ symbol for the convolution operator. Express the final result as luminance. [3 marks]