Question 8

Consider N intensity levels of R, G, B.

*For conversion into greyscale, G = w1*R + w2*B + w3*G where w1 + w2 + w3 = 1*

Minimum and maximum grey values are equal to min{R,G,B) and max(R,G,B). Call this I_min, I_max. We know that I_max – I_min = N-1 since each channel has maximum N intensity levels.

If we weight R, G equally, then shades of grey can only increment by 0.5, so we have 2(N-1) + 1 shades of grey. If we weight all 3 channels equally, then shades of grey increments by 1/3, so we have 3*(N-1) + 1 shades of grey.*

Example: N = 4, one possible set of R, G, B values are 0, 1, 2, 3; we weight all 3 channels equally, then possible shades of grey are

0, 0.33, 0.66, 1, 1.33, … 3 → 3*3 + 1 = 10; 10 shades → 4 bits to encode.

Question 9

Version with images: The number of boundary points between the black and white regions is much larger in the checker-board image. When the images get blurred, the boundary points will give rise to a larger number of different values for the checkerboard image, so the histograms of the two blurred images will be different.

Many students interpreted the black squares as single pixels. This is not stated and should not be assumed. However, I accepted answers with such assumptions.

Version without images: in general, when an image gets blurred, its histogram will change because the image intensities values will change.

Question 10

(a) description: The entire image settles at a uniform value close to the average of the input image.

Justification: Regardless of kernel weights, because the values are all between 0 – 1 and sum up to 1, the kernel has a smoothing or blurring effect. Applying this kernel many times repeatedly blurs the input; in the limit, this will result in a uniform output.

(b) description: If zero-padding is used to handle the borders, the resulting image goes to 0.

Justification: We are smoothing the image contents, but at each iteration, introduce 0 values in the borders, so we progressive lower the average value until it eventually tends towards 0.

2 marks total: (a) 0.5 + 0.5 answer describing how the output image will look + explanation / justification; (b) 0.5 + 0.5 describing how the image will look + explanation / justification;

The size of the output was not commented on and was not the focus of the question. However, given that we are doing padding, it is assumed that we will have either the same sized output or (less likely, since we are filtering infinitely many times) "full" output, but the above answer will still hold.