TASK 1

1. <u>What is the theoretical maximum value of ƒ u_max and ƒ v_max if error-free image reconstruction from the digital image should be possible (not using any compressive-sensing techniques)?</u>

The theoretical maximum spatial frequencies f u_max and f v_max that can be represented without aliasing, based on the sampling rates provided. This can be solved using the **Nyquist-Shannon sampling theorem**, which states that the maximum representable frequency is half the sampling frequency.

So:

The sampling interval in the x-direction (Δx) and the y-direction (Δy) respectively:

Δx = 1/20 samples/mm & Δy = 1/10 samples/mm

Based on the Nyquist-Shannon theorem states the maximum frequency that can be represented without aliasing is:

f_max = 1/2Δ

Thus we get the theoretical maximum values:

f_umax = 1/2Δx = 10 cycles/mm & f_vmax = 1/2Δy = 5 cycles/mm

2. <u>What is the minimum memory requirement for the color image ƒ_F (x, y) when stored in a conventional computer system, if 1024 values are to be distinguished per color channel. Describe the image format to be used.</u>

Sampling Rate: 20 samples/mm in the x-direction and 10 samples/mm in the y-direction.

Image Dimensions: Assume the image dimensions are W×H mm.

Color Channels: A color image typically has three channels: Red, Green, and Blue (RGB).

Bit Depth: Each channel can distinguish 1024 values. This implies a bit depth of:

Bit depth per channel=log_2(1024)=10 bits.

So,

Number of sampling points=(20samples/mm)·(10samples/mm)·W·H=200·W·H samples

Memory per sample=3·10=30bits = 3.75 bytes

So: **Total memory=(Number of sampling points)·(Memory per sample in bytes) = 750·W·H bytes**

Since we are at a 10 bits RGB image case the only known format that easily deals with this in a lossless manner is TIFF (can go to 3×16 bits).

3. <u>How many colors could be represented with the quantization chosen in sub-task 2?</u>

Since there are 1024 potential values per color channel, there are as many color representations as the number of value combinations.

So, # of combinations = 1024^3 = 1,073,741,824 colors represented with the quantization we chose.