2. A binary image $f(x, y)$ shown in Figure 1 has value 1 for white pixels and 0 for black pixels. The boundary of the image is plotted in Figure 2. A LSI filter mask $h(x, y)$ has value 1 inside a circle and 0 outside the circle. The area of the filter mask (circle) is 63. The diameter d of the filter mask is larger than that of the smallest circle and the width of the strip in Figure 1 but smaller than those of the two larger circles in Figure 1. Let $g(x, y)$ be the filter response to the input image $f(x, y)$, and g_{min} and g_{max} be the minimum and maximum values of $g(x, y)$, respectively.

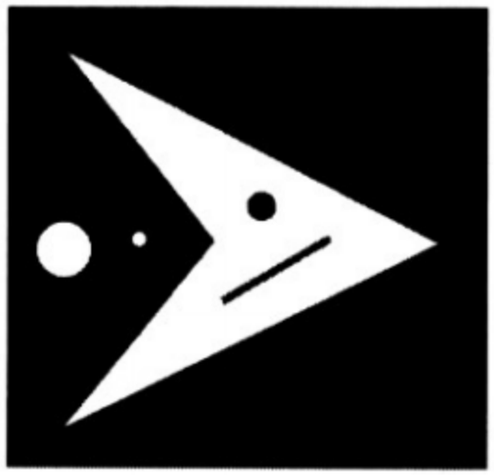

Figure 1

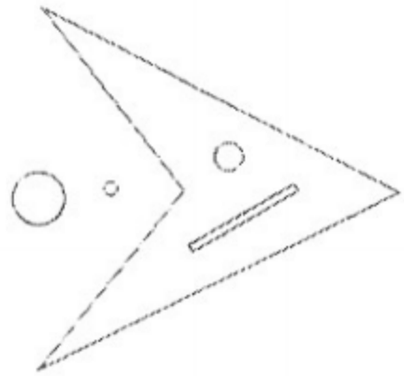

Figure 2

(a) What are the minimum value g_{min} and maximum value g_{max} of $g(x, y)$?

(4 Marks)

(b) Let $g_1(x, y)$ be the binarized image of $g(x, y)$ by setting $g_1(x, y)=1$ if $g(x, y) > g_{min}$, otherwise $g_1(x, y) = 0$. Copy Figure 2 to your answer script and plot the boundary of $g_1(x, y)$ on it.

(7 Marks)

(c) Let $g_2(x, y)$ be the binarized image of $g(x, y)$ by setting $g_2(x, y)=0$ if $g(x, y) < g_{max}$, otherwise $g_2(x, y) = 1$. Copy Figure 2 to the answer script and plot the boundary of $g_2(x, y)$ on it.

(7 Marks)

(d) As $f(x, y)$, $h(x, y)$, $g_1(x, y)$ and $g_2(x, y)$ all are binary images, which can be represented by pixel sets, express $g_1(x, y)$ and $g_2(x, y)$ by $f(x, y)$ and $h(x, y)$ in terms of set operation.

(7 Marks)