For a function $f$ in $L^1([−\pi, \pi]^2)$ its two-dimensional Fourier series is given by

$$f(x, y) = \frac{1}{4\pi^2} \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty} d_{k,l} e^{i(kx+ly)}$$

where

$$d_{k,l} = \int_{-\pi}^{\pi} \int_{-\pi}^{\pi} f(x, y) e^{-i(kx+ly)} \, dx \, dy$$

1. Find the two-dimensional Fourier series of $f(x, y)$ defined by $f(x, y) = 1$ when $-\pi/2 \leq x \leq \pi/2$ and $-\pi/2 \leq y \leq \pi/2$ and $f(x, y) = 0$ for all other $(x, y)$ in $[-\pi, \pi]^2$.

2. Find the two dimensional Fourier series in $[-\pi, \pi]^2$ of $f(x, y) = xy$.

3. If $f$ is real valued, show that $d_{-k,-l} = \overline{d_{k,l}}$. 