(a) Proof:

Commutative: $g * f[n] = \sum_{k=0}^{N-1} g(n-k) f(k) = \sum_{k=0}^{N-1} f(k) g(n-k)$

Let $n-k = m$ $\quad g * f[n] = \sum_{m=0}^{N-1} f(n-m) g(m) = f * g$

Associative: $((f*g)*h)[n] = \sum_{k=0}^{n} (f*g)(k) h(n-k)$

$= \sum_{k=0}^{n} \sum_{l=0}^{k} f(l) g(k-l) h(n-k) = \sum_{l=0}^{n} \sum_{k=l}^{n} f(l) g(k-l) h(n-k)$

$= \sum_{l=0}^{n} \sum_{k=0}^{n-l} f(l) g(k) h(n-k-l) = \sum_{l=0}^{n} f(l) (g*h)(n-l) = (f*(g*h))[n]$

(b) Solution:

$$H = \begin{bmatrix} H[0,0] & H[0,1] & \cdots & H[0,N-1] \\ \vdots & & & \\ H[M-1,0] & H[M-1,1] & \cdots & H[M-1,N-1] \end{bmatrix}$$

(c) Proof:

$g[m,n] = g[m,n] * f[m,n] = f[m,n] * g[m,n]$

$= \sum_{j=-\infty}^{\infty} \sum_{i=-\infty}^{\infty} f[i,j] \cdot g[m-i, n-j]$

$= \sum_{j=-\infty}^{\infty} \sum_{i=-\infty}^{\infty} f_1(i) \cdot f_2(j) \cdot g[m-i, n-j]$

$= \sum_{j=-\infty}^{\infty} f_2(j) \sum_{i=-\infty}^{\infty} f_1(i) \cdot g[m-i, n-j]$

$= f_2[n] * (f_1[m] * g[m,n])$

$= f_1[m] * (f_2[n] * g[m,n])$