4) i) $\{x, y+z\} = xM(y+z)^+$
$= xMy^+ + xMz^+$
$= \{x, y\} + \{x, z\}$

ii) $\{x+y, z\} = (x+y)Mz^+$
$= xMz^+ + yMz^+$
$= \{x, z\} + \{y, z\}$

iii) $\{a x, y\} = a xMy^+ = (ax)My^+$
$= \{ax, y\}$

$\{x, ay\} = xM(ay)^+ = xMy^+\bar{a}$
$= xMy^+\bar{a}$ since $\bar{a}$ is just a complex number

$\{x, ay\} = \{x, y\}\bar{a}$

None of properties i) to iii) demand any conditions on M, since operation is linear, automatically

iv) $\{x, y\} = xMy^+ = \bar{x}\bar{M}y^T$

$\bar{M}y^T = (\bar{m}_{11}y_1 + \bar{m}_{12}y_2 + \dots + \bar{m}_{1n}y_n, \dots\dots, \bar{m}_{n1}y_1 + \dots\dots + \bar{m}_{nn}y_n)^T$
$= \left(\sum_{r=1}^{n} \bar{m}_{ir} y_r\right)^T$

which is a vector in $\mathbb{R}^n$, which i is the index.

$\bar{x}\bar{M}y^T = \bar{x}\left(\sum_{r=1}^{n} \bar{m}_{ir} y_r\right)^T = \sum_{i=1}^{n}\sum_{r=1}^{n} \bar{x}_i \bar{m}_{ir} y_r$

$\{y, x\} = yMx^+$

$Mx^+ = \left(\sum_{r=1}^{n} m_{ir}\bar{x}_r\right)^T$, a vector in $\mathbb{R}^n$

$yMx^+ = y\left(\sum_{r=1}^{n} m_{ir}\bar{x}_r\right)^T = \sum_{i=1}^{n}\sum_{r=1}^{n} y_i m_{ir}\bar{x}_r$

$\bar{x}\bar{M}y^T = yMx^+$ demands

$$\sum_{i=1}^{n}\sum_{r=1}^{n} \bar{x}_i \bar{m}_{ir} y_r = \sum_{i=1}^{n}\sum_{r=1}^{n} y_i m_{ir}\bar{x}_r$$