Q7: We first consider the sum

$$\sum_{k=0}^{n} \cos(kx+y) + i\sin(kx+y)$$

Suing Eulers identity we can rewrite this as

$$\sum_{k=0}^{n} e^{i(kx+y)} = e^{iy}\sum_{k=0}^{n} e^{ikx} = e^{iy}\frac{1-e^{i(n+1)x}}{1-e^{ix}}$$

Further manipulating, we see that

$$\begin{aligned}
e^{iy}\frac{1-e^{i(n+1)x}}{1-e^{ix}} &= e^{iy}\frac{(e^{\frac{ix(n+1)}{2}})(e^{\frac{-ix(n+1)}{2}} - e^{ixn+\frac{ix(n+1)}{2}})}{e^{\frac{ix}{2}}(e^{\frac{-ix}{2}} - e^{\frac{ix}{2}})} \\
&= \frac{e^{\frac{ix}{2}} \cdot e^{i(\frac{nx}{2}+y)} \cdot (-2i\sin(\frac{n+1}{2}x))}{e^{\frac{ix}{2}} \cdot -2i \cdot \sin(\frac{x}{2})} \\
&= \frac{(\cos(\frac{n}{2}x+y) + i\sin(\frac{n}{2}x+y)) \cdot \sin(\frac{n+1}{2}x)}{\sin(\frac{x}{2})} \\
&= \frac{\cos(\frac{n}{2}x+y)\sin(\frac{n+1}{2}x)}{\sin(\frac{x}{2})} + i\frac{\sin(\frac{n}{2}x+y)\sin(\frac{n+1}{2}x)}{\sin(\frac{x}{2})}
\end{aligned}$$

Since this is equal to the original quantity, the real and complex components must be equal and hence we achieve the desired equality.