Define $v[n] = x[n] + 0.5x[n-1]$

$y[n] = v[n] + 0.5y[n-1]$

$y[n] = \sum_{k=0}^{\infty} (0.5)^k v[n-k]$ (eq 1.115/1.116)

$y[n] = \sum_{k=0}^{\infty} (0.5)^k \left(x[n-k] + 0.5x[n-k-1]\right)$

$y[n] = \sum_{k=0}^{\infty} (0.5)^k x[n-k] + \sum_{k=0}^{\infty} \left[0.5^k + 0.5x[n-k-1]\right]$

$\sum_{k=0}^{\infty} \left[0.5^{(k+1)} \times [n-(k+1)]\right]$

$m = k+1$

$\sum_{m=1}^{\infty} \left[0.5^m \times [n-m]\right]$

$\sum_{k=1}^{\infty} \left[0.5^k \times [n-k]\right]$

$y[n] = \sum_{k=0}^{\infty} (0.5)^k x[n-k] +$

$y[n] = (0.5)^{k=0} \times [n-(k=0)] + 2\sum_{k=1}^{\infty} 0.5^k \times [n-k]$

$$y[n] = x[n] + 2\sum_{k=1}^{\infty} 0.5^k x[n-k]$$