Instead of working with $P_k(t)$, which denotes the proportion of k degree vertices at time t, we define $N_k(t)$ which would denote the total number of k degree vertices at time t. In $G_t^{(1,p)}$, define

$$N_k(t) = \sum_{i=1}^{t+2} \mathbb{1}_{\{D_i(t)=k\}} = (t+2)P_k(t).$$

We now find the conditional expectation $\mathbb{E}(N_k(t+1) \,|\, \mathcal{F}_t)$.

$$\mathbb{E}(N_k(t+1) \,\big|\, \mathcal{F}_t) = N_k(t) + \mathbb{E}(N_k(t+1) - N_k(t) \,\big|\, \mathcal{F}_t).$$