Solution to Problem 4.3

$$\text{Mean Idle Period} = \overline{IP} = \frac{1}{\boldsymbol{1}_I}$$

$$\text{Mean Busy Period} = \overline{BP} = \frac{\overline{X}}{1 - \boldsymbol{1}_B \overline{X}}$$

Therefore, we can find that

$$p_0 = \frac{\overline{IP}}{\overline{IP} + \overline{BP}} = \frac{1 - \boldsymbol{1}_B \overline{X}}{1 + (\boldsymbol{1}_I - \boldsymbol{1}_B)\overline{X}}$$

$$\boldsymbol{1}_{\textit{eff}} = \boldsymbol{1}_I p_0 + \boldsymbol{1}_B (1 - p_0) = \frac{\boldsymbol{1}_I}{1 + (\boldsymbol{1}_I - \boldsymbol{1}_B)\overline{X}}$$

$$R = \frac{1}{2}\boldsymbol{1}_{\textit{eff}} \overline{X^2}$$

$$W_q = \boldsymbol{1}_{\textit{eff}} W_q \overline{X} + R = \frac{1}{2}\frac{\boldsymbol{1}_I \overline{X^2}}{1 - \boldsymbol{1}_B \overline{X}}$$