(a) \( E[ M_{t+1} | X_0, ..., X_t ] = X_{t+1} + \lambda (t+1) \)

\[ = X_t + E[Y_{t+1}] + \lambda t + \lambda \]

\[ = M_t + \left( \frac{\lambda}{5} - \frac{\lambda}{6} \right) + \lambda \]

\[ = M_t + \lambda - \frac{\lambda}{5} \]

So we read \( \lambda = \frac{1}{5} \)

(b) The event \( \{ T = t \} \) is

\[ \{ X_t = 0 \} \cap \bigcap_{s=0}^{t-1} \{ X_s \neq 0 \} \]

which depends only on \( X_0, ..., X_t \)

(c) \( E[ M_{\infty} ] = E[ M_0 ] \) by martingale property

\[ = E[ X_0 ] = 100 \]

(d) Optional stopping theorem: we have \( E[ T ] < \infty \), and

\[ |M_{t+1} - M_t| = |X_{t+1} + \lambda| < \frac{\lambda}{5} \text{ bounded} \]

By the theorem, \( E[ M_T ] = E[ M_0 ] = 100 \)

\[ E[ X_T + \lambda T ] = 100 \]

or since \( X_T = 0 \), \( E[T] = \frac{100}{\lambda} = 500 \)