Uniform Distribution:

$$p(x) = \begin{cases} 1 & 0 < x < 1 \\ 0 & \text{otherwise} \end{cases}$$

Mean of Uniform Distribution:

$$\begin{aligned} \mu &= \int_{-\infty}^{+\infty} xp(x)\ dx = \int_{-\infty}^{0} xp(x)\ dx + \int_{0}^{1} xp(x)\ dx + \int_{1}^{+\infty} xp(x)\ dx \\ &= \int_{-\infty}^{0} 0\ dx + \int_{0}^{1} x\ dx + \int_{1}^{+\infty} 0\ dx = \int_{0}^{1} x\ dx = \left[\frac{x^2}{2}\right]_{x=0}^{1} = \frac{1}{2} \end{aligned}$$

Variance of Uniform Distribution:

$$\begin{aligned} \sigma^2 &= \int_{-\infty}^{+\infty} p(x)(x-\mu)^2\ dx = \int_{-\infty}^{0} p(x)(x-\frac{1}{2})^2\ dx + \int_{0}^{1} p(x)(x-\frac{1}{2})^2\ dx \\ &+ \int_{1}^{+\infty} p(x)(x-\frac{1}{2})^2\ dx = \int_{-\infty}^{0} 0\ dx + \int_{0}^{1} (x-\frac{1}{2})^2\ dx + \int_{1}^{+\infty} 0\ dx \\ &= \int_{0}^{1} (x-\frac{1}{2})^2\ dx = \left[\frac{(x-\frac{1}{2})^3}{3}\right]_{x=0}^{1} = \frac{1}{24} + \frac{1}{24} = \frac{1}{12} \end{aligned}$$