Misc. formulas:

$_nP_k = \frac{n!}{(n-k)!}$ $\binom{n}{k} = \frac{n!}{k!(n-k)!}$ $\binom{n}{n_1, n_2, \ldots, n_k} = \frac{n!}{n_1! n_2! \cdots n_k!}$

$\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A \cap B)$ $\mathrm{P}(A \mid B) = \frac{\mathrm{P}(A \cap B)}{\mathrm{P}(B)}$

$\mathrm{P}(A \cup B \cup C) = \mathrm{P}(A) + \mathrm{P}(B) + \mathrm{P}(C) - \mathrm{P}(A \cap B) - \mathrm{P}(A \cap C) - \mathrm{P}(B \cap C) + \mathrm{P}(A \cap B \cap C)$

$\mathrm{P}\left(\bigcup_{i=1}^n A_i\right) = \sum_{i=1}^n \mathrm{P}(A_i) - \sum_{i<j} \mathrm{P}(A_i \cap A_j) + \sum_{i<j<k} \mathrm{P}(A_i \cap A_j \cap A_k) + \cdots + (-1)^{n-1} \sum_{i<\ldots<n} \mathrm{P}\left(\bigcap_{i=1}^n A_i\right)$

$$P(B \mid A) = \frac{P(A \mid B)P(B)}{P(A \mid B)P(B) + P(A \mid B^c)P(B^c)} \qquad P(B_k \mid A) = \frac{P(A \mid B_k)P(B_k)}{\sum_{i=1}^n P(A \mid B_i)P(B_i)}$$

$\mathrm{Var}(X) = E[(X - \mathrm{E}(X))^2] = E(X^2) - [E(X)]^2 = E(X^2) - \mu_X^2$ $\mathrm{Var}(X) = \mathrm{Cov}(X, X)$

$\mathrm{Cov}(X, Y) = E[(X - \mu_X)(Y - \mu_Y)]$ $\mathrm{Cov}(X, Y) = E[XY] - \mu_X \mu_Y$

$M_X(t) = \mathrm{E}[e^{tX}]$ $m_n = \mu_n' = \mathrm{E}(X^n)$ $\mu_n = \mathrm{E}[(X - \mu_X)^n]$ $M_{\frac{X+a}{b}} = e^{\frac{a}{b}t} M_X(\frac{t}{b})$

If $Y_1 = \sum_{i=1}^n a_i X_i$ and $Y_2 = \sum_{i=1}^n b_i X_i$ then:

$\mathrm{E}(Y_1) = \sum_{i=1}^n a_i \mathrm{E}(X_i)$

$\mathrm{Var}(Y_1) = \sum_{i=1}^n a_i^2 \mathrm{Var}(X_i) + 2\sum_{i=1}^n a_i b_i \mathrm{Cov}(X_i, X_j)$

$\mathrm{Cov}(Y_1, Y_2) = \sum_{i=1}^n a_i b_i \mathrm{Var}(X_i) + \sum_{i<j} (a_i b_j + a_j b_i)\mathrm{Cov}(X_i, X_j)$

$\mathrm{E}(X \mid a < X < b) = \frac{\int_A x f_X(x)\ dx}{P(X \in A)} = \frac{\int_a^b x f_X(x)\ dx}{\int_a^b f_X(x)}$

$\mathrm{E}(X \mid c < Y < d) = \frac{\int_{-\infty}^{\infty} \int_c^d x f(x,y)\ dy\ dx}{P(c<Y<d)} = \frac{\int_{-\infty}^{\infty} \int_c^d x f(x,y)\ dy\ dx}{\int_{-\infty}^{\infty} \int_c^d f(x,y)\ dy\ dx}$

$\mathrm{E}(X \mid Y = y) = \int_{-\infty}^{\infty} x f_{X|Y=y}(x|y)\ dx = \int_{-\infty}^{\infty} x \frac{f(x,y)}{f_Y(y)}\ dx$

$$\mathrm{E}(u(X, Y) \mid a < X < b, c < Y < d) = \frac{\int_c^d \int_a^b u(x, y) f(x, y)\ dx\ dy}{\mathrm{P}(a < X < b, c < Y < d)} = \frac{\int_c^d \int_a^b u(x, y) f(x, y)\ dx\ dy}{\int_c^d \int_a^b f(x, y)\ dx\ dy}$$

$\Gamma(\alpha) = \int_0^\infty t^{\alpha-1} e^{-t} dt$ $\Gamma(n) = (n-1)!$ $(2n-1)!! = \frac{(2n)!}{2^n n!}$ $(2n)!! = 2^n n!$

Distributions:

$f_X(x) = \binom{n}{x} \theta^x (1-\theta)^{n-x}$ for $x = 0, 1, 2, \ldots, n$ $\mathrm{E}(X) = n\theta$ $\mathrm{Var}(X) = n\theta(1-\theta)$ $M_X(t) = (1 - \theta + \theta e^t)^n$

$f_X(x) = \theta(1-\theta)^{x-1}$ for $x = 1, 2, 3, \ldots$ $\mathrm{E}(X) = \frac{1}{\theta}$ $\mathrm{Var}(X) = \frac{(1-\theta)}{\theta^2}$ $M_X(t) = \frac{\theta e^t}{1-\theta+\theta e^t}$

$f_X(x) = \binom{x-1}{k-1} \theta^k (1-\theta)^{x-k}$ for $x = k, k+1, k+2, \ldots$ $\mathrm{E}(X) = \frac{k}{\theta}$ $\mathrm{Var}(X) = \frac{k(1-\theta)}{\theta^2}$ $M_X(t) = \left(\frac{\theta e^t}{1-\theta+\theta e^t}\right)^k$

$f_X(x) = \frac{e^{-\lambda} \lambda^x}{x!}$ for $x = 0, 1, 2, \ldots$ $\mathrm{E}(X) = \lambda$ $\mathrm{Var}(X) = \mu$ $M_X(t) = e^{\lambda(e^t - 1)}$

$f_X(x) = \alpha e^{-\alpha x}$ or $f_X(x) = \frac{1}{\theta} e^{-x/\theta}$ for $x \geq 0$ $\mathrm{E}(X) = \frac{1}{\alpha} = \theta$ $\mathrm{Var}(X) = \frac{1}{\alpha^2} = \theta^2$ $M_X(t) = (1 - \frac{1}{\alpha} t)^{-1} = (1 - \theta t)^{-1}$

$f_X(x) = \dfrac{1}{\beta^\alpha \Gamma(\alpha)} x^{\alpha-1} e^{-x/\beta}$ for $x \geq 0$ $\mathrm{E}(X) = \alpha\beta$ $\mathrm{Var}(X) = \alpha\beta^2$ $M_X(t) = (1 - \beta t)^{-\alpha}$

$f_X(x) = \dfrac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$ for $-\infty < x < \infty$ $\mathrm{E}(X) = \mu$ $\mathrm{Var}(X) = \sigma^2$ $M_X(t) = e^{\mu t + \frac{1}{2}\sigma^2 t^2}$ $\mu_{2n} = (2n-1)!!\sigma^{2n}$