Part I: <u>Summary of Confidence Intervals:</u>

(I) CI for the Population Mean μ:

Case 1: Large sample ($n \geq 30$):

CI: $(\bar{x} - E, \bar{x} + E)$

$E = z_c \frac{s}{\sqrt{n}}$

$z_c = NORM.S.INV\left(\frac{1+c}{2}\right)$

Determining the ample size: $n = \left(\frac{z_c\, s}{E}\right)^2$

Case 2: Small sample, Population is normal, σ is given: Same as case 1.

Case 3: Small sample, Population is normal, σ is unknown:

CI: $(\bar{x} - E, \bar{x} + E)$

$E = t_c \frac{s}{\sqrt{n}}$

$DF = n - 1;$

$t_c = T.INV\left(\frac{1+c}{2}, DF\right)$

(II) CI for the Population Proportion p:

First ensure that $n\,\hat{p} \geq 10$ and $n\,\hat{q} \geq 10$; where : $\hat{p} = \frac{x}{n}$ is the sample proportion and $\hat{q} = 1 - \hat{p}$.

Next,

CI: $(\hat{p} - E, \hat{p} + E)$

$E = z_c \sqrt{\frac{\hat{p}\,\hat{q}}{n}}$

$z_c = NORM.S.INV\left(\frac{1+c}{2}\right).$

Determining the sample size: $n = \hat{p}\,\hat{q}\left(\frac{z_c}{E}\right)^2.$

(III) **CI for the Population Standard Deviation $\boldsymbol{\sigma}$:**

CI Lower Limit for $\boldsymbol{\sigma}$: $\sqrt{\dfrac{(n-1)\, s^2}{\chi^2_R}}$

CI Upper Limit for $\boldsymbol{\sigma}$: $\sqrt{\dfrac{(n-1)\, s^2}{\chi^2_L}}$

$\chi_R{}^2 := CHISQ.INV\left(\frac{1+c}{2}, DF\right)$

$\chi_L{}^2 := CHISQ.INV\left(\frac{1-c}{2}, DF\right)$

$DF = n - 1;$

Part II Hypothesis Testing Summary:

(I) Hypothesis testing for a population mean μ: (large sample: $n \geq 30$)

	Right Tailed Problem	Left-Tailed Problem	Two Tailed Problem:
Hypotheses	$Null: \quad H_a: \ \mu \le \mu_o$ $Alternative: \ H_a: \ \mu > \mu_o$	$Null: \quad H_a: \ \mu \ge \mu_o$ $Alternative: \ H_a: \ \mu < \mu_o$	$Null: \quad H_a: \ \mu = \mu_o$ $Alternative: \ H_a: \ \mu \ne \mu_o$
Test Statistic z	$z = \dfrac{(\bar{x} - \mu_o)\sqrt{n}}{s}$	$z = \dfrac{(\bar{x} - \mu_o)\sqrt{n}}{s}$	$z = \dfrac{(\bar{x} - \mu_o)\sqrt{n}}{s}$
<u>P-Value:</u>	$P(Z \ge z)$ ***<u>Excel</u>:*** **= 1 – norm.s.dist(z , 1)**	$P(Z \le z)$ ***<u>Excel</u>:*** **= norm.s.dist(z , 1)**	$\begin{cases} 2P(Z \ge z) & if \ \ z \text{ is positive} \\ 2P(Z \le z) & if \ \ z \text{ is negative} \end{cases}$ ***<u>Excel</u>:*** $\begin{cases} \mathbf{2 * (1 - norm.s.dist(z\,,1))} & \textbf{if } z \ge 0 \\ \mathbf{2 * norm.s.dist(z\,,1)} & \textbf{if } z < 0 \end{cases}$
<u>Critical Value(s)</u>	*Z_c with an area of α on its right* ***<u>Excel</u>:*** **= norm.s.inv(1 – α)**	*Z_c with an area of α on its left* ***<u>Excel</u>:*** **= norm.s.inv(α)**	*Critical 1*: *Z_c with an area of $\alpha/2$ on its left* ***<u>Excel</u>:*** **= norm.s.inv($\alpha/2$)** *Critical 2*: *Z_c with an area of $\alpha/2$ on its right* ***<u>Excel</u>:*** **= norm.s.inv(1 – $\alpha/2$)**
Decision (Using the Critical values):	*Reject Ho if $z \ge Z_c$*	*Reject Ho if $z \le Z_c$*	$\begin{cases} \textbf{if } z < 0, \ \textbf{reject Ho if} & z \le \textbf{Critical 1} \\ \textbf{If } z > 0, \ \textbf{reject Ho if} & z \ge \textbf{Critical 2} \end{cases}$
Decision (Using the P-values):	*Reject H_o if Pvalue $\le \alpha$*	*Reject H_o if Pvalue $\le \alpha$*	*Reject H_o if Pvalue $\le \alpha$*

(II) Hypothesis testing for a population mean μ: (small sample, population is Normal, σ is unknown)

	Right Tailed Problem	**Left-Tailed Problem**	**Two Tailed Problem:**
Hypotheses	$Null: \quad H_a: \ \mu \le \mu_o$ $Alternative: \ H_a: \ \mu > \mu_o$	$Null: \quad H_a: \ \mu \ge \mu_o$ $Alternative: \ H_a: \ \mu < \mu_o$	$Null: \quad H_a: \ \mu = \mu_o$ $Alternative: \ H_a: \ \mu \ne \mu_o$
Test Statistic t	$t = \dfrac{\left(\bar{x} - \mu_o\right)\sqrt{n}}{s}$	$t = \dfrac{\left(\bar{x} - \mu_o\right)\sqrt{n}}{s}$	$t = \dfrac{\left(\bar{x} - \mu_o\right)\sqrt{n}}{s}$
<u>P-Value:</u>	$P\left(T \ge t\right)$ ***<u>Excel</u>:*** **= 1 – T.DIST(*t* , *df*, 1)** ***df* = *n*- 1**	$P\left(T \le t\right)$ ***<u>Excel</u>:*** **= T.DIST(*t* , *df*, 1)**	$\begin{cases} 2P\left(T \ge t\right) \ if \ \ t \ is \ positive \\ 2P\left(T \le t\right) \ if \ \ t \ is \ negative \end{cases}$ ***<u>Excel</u>:*** $\begin{cases} \mathbf{2 * (1 - T.DIST(\mathit{t}, \mathit{df}, 1))} & \mathbf{if} \ \mathbf{\mathit{t} \ge 0} \\ \mathbf{2 * T.DIST(\mathit{t}, \mathit{df}, 1)} & \mathbf{if} \ \mathbf{\mathit{t} < 0} \end{cases}$
<u>Critical Value(s)</u>	*T_c with an area of α on its right* ***<u>Excel</u>:*** **= T.INV(1 – *α* , *df*)**	*T_c with an area of α on its left* ***<u>Excel</u>:*** **= T.INV(*α* , *df*)**	*Critical 1*: *T_c with an area of $\alpha/2$ on its left* ***<u>Excel</u>:*** **= T.INV(*α*/2 , *df*)** *Critical 2*: *T_c with an area of $\alpha/2$ on its right* ***<u>Excel</u>:*** **= T.INV(1 – *α*/2 , *df*)**
Decision (Using the Critical values):	*Reject Ho if $t \ge T_c$*	*Reject Ho if $z \le T_c$*	$\begin{cases} \textbf{if } t < 0, \ \textbf{reject Ho if } \ t \le \textbf{Critical 1} \\ \textbf{If } t > 0, \ \textbf{reject Ho if } \ t \ge \textbf{Critical 2} \end{cases}$
Decision (Using the P-values):	$Reject \ H_o \ if \ \ Pvalue \le \alpha$	$Reject \ H_o \ if \ \ Pvalue \le \alpha$	$Reject \ H_o \ if \ \ Pvalue \le \alpha$

(III) **Hypothesis testing for a population Proportion p:**

	Right Tailed Problem	**Left-Tailed Problem**	**Two Tailed Problem:**
Hypotheses	$Null: \quad H_a: p \le p_o$ $Alternative: H_a: p > p_o$	$Null: \quad H_a: p \ge p_o$ $Alternative: H_a: p < p_o$	$Null: \quad H_a: p = p_o$ $Alternative: H_a: p \ne p_o$
Test Statistic z	$z = \dfrac{\hat{p} - p_o}{\sqrt{\dfrac{p_o q_o}{n}}}$	$z = \dfrac{\hat{p} - p_o}{\sqrt{\dfrac{p_o q_o}{n}}}$	$z = \dfrac{\hat{p} - p_o}{\sqrt{\dfrac{p_o q_o}{n}}}$
P-Value:	$P(Z \ge z)$ ***Excel:*** **= 1 – norm.s.dist(*z* , 1)**	$P(Z \le z)$ ***Excel:*** **= norm.s.dist(*z* , 1)**	$\begin{cases} 2P(Z \ge z) & if \;\; z \text{ is positive} \\ 2P(Z \le z) & if \;\; z \text{ is negative} \end{cases}$ ***Excel:*** $\begin{cases} \mathbf{2 * (1 - norm.s.dist(z\,,1))} & \mathbf{if}\; z \ge 0 \\ \mathbf{2 * norm.s.dist(z\,,1)} & \mathbf{if}\; z < 0 \end{cases}$
Critical Value(s)	*Z_c with an area of α on its right* ***Excel:*** **= norm.s.inv(1 – *α*)**	*Z_c with an area of α on its left* ***Excel:*** **= norm.s.inv(*α*)**	*Critical 1*: *Z_c with an area of $\alpha/2$ on its left* ***Excel:*** **= norm.s.inv(*α*/2)** *Critical 2*: *Z_c with an area of $\alpha/2$ on its right* ***Excel:*** **= norm.s.inv(1 – *α*/2)**
Decision (Using the Critical values):	*Reject Ho if $z \ge Z_c$*	*Reject Ho if $z \le Z_c$*	$\begin{cases} \textbf{if } z < 0, \textbf{ reject Ho if } & z \le \textbf{Critical 1} \\ \textbf{If } z > 0, \textbf{ reject Ho if } & z \ge \textbf{Critical 2} \end{cases}$
Decision (Using the P-values):	*Reject H_o if Pvalue $\le \alpha$*	*Reject H_o if Pvalue $\le \alpha$*	*Reject H_o if Pvalue $\le \alpha$*

(IV) Hypothesis testing for a population Standard Deviation σ:

	Right Tailed Problem	Left-Tailed Problem	Two Tailed Problem:
Hypotheses	$Null: \quad H_a: \sigma \le \sigma_o$ $Alternative: H_a: \sigma > \sigma_o$	$Null: \quad H_a: \sigma \ge \sigma_o$ $Alternative: H_a: \sigma < \sigma_o$	$Null: \quad H_a: \sigma = \sigma_o$ $Alternative: H_a: \sigma \ne \sigma_o$
Test Statistic χ^2	$\chi^2 = \frac{(n-1)s^2}{\sigma_o^2}$	$\chi^2 = \frac{(n-1)s^2}{\sigma_o^2}$	$\chi^2 = \frac{(n-1)s^2}{\sigma_o^2}$
<u>P-Value:</u>	$P(X^2 \ge \chi^2)$ ***<u>Excel</u>:*** **= 1 – chisq.dist(χ^2 , df , 1)** ***df = n – 1***	$P(X^2 \le \chi^2)$ ***<u>Excel</u>:*** **= chisq.dist(χ^2 , df , 1)**	**The smaller of** **2 $P(X^2 \ge \chi^2)$ or 2 $P(X^2 \le \chi^2)$** ***<u>Excel</u>:*** **The smaller of** **= 2* (1 – chisq.dist(χ^2 , df , 1))** **Or** **= 2* chisq.dist(χ^2 , df , 1)**
<u>Critical Value(s)</u>	*χ_c^2 with an area of α on its right* ***<u>Excel</u>:*** **= chisq.inv(1 – α , *df*)**	*χ_c^2 with an area of α on its left* ***<u>Excel</u>:*** **= chisq.inv(α , *df*)**	*Critical 1:* *χ_c^2 with an area of $\alpha/2$ on its left* ***<u>Excel</u>:*** **= chisq.inv($\alpha/2$, *df*)** *Critical 2:* *χ_c^2 with an area of $\alpha/2$ on its right* ***<u>Excel</u>:*** **= chisq.inv(1 – $\alpha/2$, *df*)**
Decision (Using the Critical values):	*Reject Ho if $\chi^2 \ge \chi_c^2$*	*Reject Ho if $\chi^2 \le \chi_c^2$*	*Reject Ho if either $\chi^2 \le$ Critical 1, or if $\chi^2 \ge$ Critical 2*
Decision (Using the P-values):	*Reject H_o if Pvalue $\le \alpha$*	*Reject H_o if Pvalue $\le \alpha$*	*Reject H_o if Pvalue $\le \alpha$*

Part III: Summary of Continuous Probability Formulas in Excel

1. **The Normal Distribution:**

(i) Standard Normal Distribution Z

$$P\left(Z \le z\right): \quad \underline{= NORM.S.DIST\left(z,1\right)}$$

$$z: \quad \underline{= NORM.S.INV\left(P\left(Z \le z\right)\right)}$$

$P\left(Z \le z\right)$ **represents the area on the left of** z

(ii) Non-Standard Normal Distribution X

$$P\left(X \le x\right): \quad \underline{= NORM.DIST\left(x,\mu,\sigma,1\right)}$$

$$x: \quad \underline{= NORM.INV\left(P\left(X \le x\right),\mu,\sigma\right)}$$

$P\left(X \le x\right)$ **represents the area on the left of** x

2. **The T Distribution** T **(DF = n – 1)**

$$P\left(T \le t\right): \qquad \underline{= T.DIST\left(t, df\right)}$$

$$t: \qquad \underline{= T.INV\left(P\left(T \le t\right), df\right)}$$

$P\left(T \le t\right)$ **represents the area on the left of** t

3. **The Chi-squared Distribution** X^2 **(DF = n – 1)**

$$P\left(\mathrm{X}^2 \le \chi^2\right): \qquad \underline{= CHISQ.DIST\left(\chi^2, df, 1\right)}$$

$$\chi^2: \qquad \underline{= CHISQ.INV\left(P\left(\mathrm{X}^2 \le \chi^2\right), df\right)}$$

$P\left(\mathrm{X}^2 \le \chi^2\right)$ **represents the area on the left of** χ^2