MATH202 Formula Sheet

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \qquad df = n_1 + n_2 - 2$$

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

$$z = \frac{\bar{d} - D_0}{s_d / \sqrt{n_d}}$$

$$t = \frac{\bar{d} - D_0}{s_d / \sqrt{n_d}} \qquad df = n_d - 1$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad df = \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{\frac{(s_1^2/n_1)^2}{n_1 - 1} + \frac{(s_2^2/n_2)^2}{n_2 - 1}}$$

$$s_d = \sqrt{\frac{\sum_{i=1}^{n_d}(d_i - \bar{d})^2}{n_d - 1}}$$

$$z = \frac{(\hat{p}_1 - \hat{p}_2)}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$\hat{p} = \frac{x_1 + x_2}{n_1 + n_2} \qquad F = \frac{s_1^2}{s_2^2}$$

$$F = \frac{s_{\text{larger}}^2}{s_{\text{smaller}}^2}$$

$$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2}\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} \qquad df = n_1 + n_2 - 2$$

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \qquad df = \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{\frac{(s_1^2/n_1)^2}{n_1 - 1} + \frac{(s_2^2/n_2)^2}{n_2 - 1}}$$

$$\bar{d} \pm z_{\alpha/2}\frac{s_d}{\sqrt{n_d}}$$

$$\bar{d} \pm t_{\alpha/2}\frac{s_d}{\sqrt{n_d}} \qquad df = n_d - 1$$

$$(\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2}\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$$

$$SST = \sum_{i=1}^{k} n_i(\bar{x}_i - \bar{x})^2 \qquad SSE = \sum_{i=1}^{k}(n_i - 1)s_i^2 \qquad c = \binom{k}{2} = \frac{k(k-1)}{2}$$

Source	df	SS	MS
Treatment	$k-1$	SST	MST
Error	$n-k$	SSE	MSE
Total	$n-1$	$SSTotal$	

$$F = \frac{MST}{MSE}$$

$$\chi^2 = \sum \frac{(n_i - E_i)^2}{E_i} \qquad E_i = np_{i,0} \qquad df = k - 1$$

$$\chi^2 = \sum \frac{(n_{ij} - \hat{E}_{ij})^2}{\hat{E}_{ij}} \qquad \hat{E}_{ij} = \frac{R_i C_j}{n} \qquad df = (r-1)(c-1)$$

Source	df	SS	MS
Treatment	$k-1$	SST	MST
Block	$b-1$	SSB	MSB
Error	$(k-1)(b-1)$	SSE	MSE
Total	$n-1$	$SSTotal$	

$$F = \frac{MST}{MSE} \qquad F = \frac{MSB}{MSE}$$

$$SST = b\sum_{i=1}^{k}(\bar{x}_i - \bar{x})^2$$

$$SSB = k\sum_{i=1}^{b}(\bar{x}_i - \bar{x})^2$$

Source	df	SS	MS
Factor A	$a-1$	SSA	MSA
Factor B	$b-1$	SSB	MSB
Interaction	$(a-1)(b-1)$	$SSAB$	$MSAB$
Error	$n-ab$	SSE	MSE
Total	$n-1$	$SSTotal$	

$$F = \frac{MST}{MSE} \qquad F = \frac{MSAB}{MSE} \qquad F = \frac{MSA}{MSE} \qquad F = \frac{MSB}{MSE}$$

$$SST = SSA + SSB + SSAB$$

MATH202 Formula Sheet

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \qquad \hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_i \qquad SS_{xx} = \sum_{i=1}^{n}(x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}$$

$$SS_{yy} = \sum_{i=1}^{n}(y_i - \bar{y})^2 = \sum_{i=1}^{n} y_i^2 - \frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n} \qquad SS_{xy} = \sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}) = \sum_{i=1}^{n} x_i y_i - \frac{\left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{n}$$

$$\hat{\beta}_1 = \frac{SS_{xy}}{SS_{xx}} \qquad \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x} \qquad SSE = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2 = SS_{yy} - \hat{\beta}_1 SS_{xy} \qquad SSR = \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2$$

Source	df	SS	MS
Regression	k	SSR	MSR
Error	$n-(k+1)$	SSE	MSE
Total	$n-1$	SS_{yy}	

$$s = \sqrt{s^2} = \sqrt{MSE} = \sqrt{\frac{SSE}{n-(k+1)}} \qquad t = \frac{\hat{\beta}_i}{s_{\hat{\beta}_i}} \quad df = n-(k+1)$$

$$\hat{\beta}_i \pm t_{\alpha/2} s_{\hat{\beta}_i} \quad df = n-(k+1) \qquad s_{\hat{\beta}_0} = s\sqrt{\frac{1}{n} + \frac{\bar{x}^2}{SS_{xx}}} \qquad s_{\hat{\beta}_1} = \frac{s}{\sqrt{SS_{xx}}} \qquad r = \frac{SS_{xy}}{\sqrt{SS_{xx}SS_{yy}}} = \sqrt{r^2}\, sign(\hat{\beta}_1)$$

$$r^2 = \frac{SSR}{SS_{yy}} = \frac{SS_{yy} - SSE}{SS_{yy}} \qquad \hat{y} \pm t_{\alpha/2} s\sqrt{\frac{1}{n} + \frac{(x_p - \bar{x})^2}{SS_{xx}}} \quad df = n-2 \qquad \hat{y} \pm t_{\alpha/2} s\sqrt{1 + \frac{1}{n} + \frac{(x_p - \bar{x})^2}{SS_{xx}}} \quad df = n-2$$

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon \qquad \hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \ldots + \hat{\beta}_k x_k$$

$$F = \frac{MSR}{MSE} = \frac{r^2/k}{(1-r^2)/[n-(k+1)]} \qquad r_a^2 = 1 - \left[\frac{n-1}{n-(k+1)}\right](1-r^2) \qquad y_i - \hat{y}_i$$

$$F = \frac{(SSR_C - SSR_R)/(k-g)}{MSE_C} = \frac{(SSE_R - SSE_C)/(k-g)}{MSE_C} \qquad df_{num} = k-g \qquad df_{den} = n-(k+1)$$

$$VIF_j = \frac{1}{1-r_j^2}$$

MATH202 Formula Sheet

$$\bar{\bar{x}} = \frac{\bar{x}_1 + \bar{x}_2 + \cdots + \bar{x}_k}{k} \qquad \bar{R} = \frac{R_1 + R_2 + \cdots + R_k}{k} \qquad n > \frac{9(1-p_0)}{p_0}$$

$$\bar{\bar{x}} \pm A_2\bar{R} = \bar{\bar{x}} \pm 3\frac{\bar{R}/d_2}{\sqrt{n}} \qquad \bar{\bar{x}} \pm \frac{2}{3}A_2\bar{R} = \bar{\bar{x}} \pm 2\frac{\bar{R}/d_2}{\sqrt{n}} \qquad \bar{\bar{x}} \pm \frac{1}{3}A_2\bar{R} = \bar{\bar{x}} \pm \frac{\bar{R}/d_2}{\sqrt{n}}$$

$$\bar{R}D_3 = \bar{R} - 3d_3\frac{\bar{R}}{d_2} \qquad \bar{R}D_4 = \bar{R} + 3d_3\frac{\bar{R}}{d_2} \qquad \bar{R} \pm 2d_3\frac{\bar{R}}{d_2} \qquad \bar{R} \pm d_3\frac{\bar{R}}{d_2}$$

$$\bar{p} = \frac{\text{total number of successes}}{kn} \qquad \bar{p} \pm 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \qquad \bar{p} \pm 2\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \qquad \bar{p} \pm \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Rule 1: One point beyond Zone A (more than 3 SD from center line)
Rule 2: Nine points in a row in Zone C or beyond (on same side of center line)
Rule 3: Six points in a row, all increasing or all decreasing
Rule 4: Fourteen points in a row, alternating up and down
Rule 5: Two out of three points in a row in Zone A or beyond (more than 2 SD from center line, same side)
Rule 6: Four out of five points in a row in Zone B or beyond (more than 1 SD from center line, same side)
Rule 7: Fifteen points in a row in Zone C (within 1 SD of center line, either side)
Rule 8: Eight points in a row outside Zone C (more than 1 SD from center line, either side)

$$\begin{aligned} E_1 &= Y_1 & F_{t+1} &= E_t \\ E_2 &= wY_2 + (1-w)E_1 & F_{t+2} &= E_t \\ &\vdots & &\vdots \\ E_t &= wY_t + (1-w)E_{t-1} & F_{t+k} &= E_t \end{aligned}$$

$$\begin{aligned} E_2 &= Y_2 & T_2 &= Y_2 - Y_1 & F_{t+1} &= E_t + T_t \\ E_3 &= wY_3 + (1-w)(E_2 + T_2) & T_3 &= v(E_3 - E_2) + (1-v)T_2 & F_{t+2} &= E_t + 2T_t \\ &\vdots & &\vdots & &\vdots \\ E_t &= wY_t + (1-w)(E_{t-1} + T_{t-1}) & T_t &= v(E_t - E_{t-1}) + (1-v)T_{t-1} & F_{t+k} &= E_t + kT_t \end{aligned}$$

$$MAD = \frac{\sum_{t=1}^{m}|Y_t - F_t|}{m} \qquad MAPE = \frac{\sum_{t=1}^{m}\left|\frac{Y_t - F_t}{Y_t}\right|}{m}\times 100 \qquad MSD = \frac{\sum_{t=1}^{m}(Y_t - F_t)^2}{m} = \frac{SSE}{n} = \frac{n-(k+1)}{n}MSE$$

$$RMSE = \sqrt{MSD} \qquad R_t = Y_t - \hat{Y}_t \qquad d = \frac{\sum_{t=2}^{n}(R_t - R_{t-1})^2}{\sum_{t=1}^{n}R_t^2}$$

reject Ho if $d < d_L$
inconclusive if $d_L < d < d_U$
do not reject Ho if $d > d_U$

reject Ho if $d > 4 - d_L$
inconclusive if $4 - d_U < d < 4 - d_L$
do not reject Ho if $d < 4 - d_U$

reject Ho if $d < d_L$ *or* $d > 4 - d_L$
inconclusive if $d_L < d < d_U$ *or* $4 - d_U < d < 4 - d_L$
do not reject Ho if $d_U < d < 4 - d_U$