3. Letter grades are associated normal distribution, thus we need

| Grade | Interval | Prob | Expected student |
|---|---|---|---|
| A | $[\mu+2\sigma, \infty)$ | 0.023 | $600 \times 0.023 = 13.8$ |
| B | $[\mu+\sigma, \mu+2\sigma)$ | 0.136 | $600 \times 0.136 = 81.6$ |
| C | $[\mu-\sigma, \mu+\sigma)$ | 0.682 | $600 \times 0.682 = 409.2$ |
| D | $[\mu-2\sigma, \mu-\sigma)$ | 0.136 | $600 \times 0.136 = 81.6$ |
| F | $(-\infty, \mu-2\sigma)$ | 0.023 | $600 \times 0.023 = 13.8$ |
| | | | |

Total Students = 600

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

$$= \frac{(77-13.8)^2}{13.8} + \frac{(150-81.6)^2}{81.6} + \frac{(210-409.2)^2}{409.2}$$

$$+ \frac{(135-81.6)^2}{81.6} + \frac{(38-13.8)^2}{13.8}$$

$$= 289.43 + 57.33 + 96.97 + 23.8 + 43.47$$

$$= 509.28$$

$df$ = # of Categories - 1

$= 5 - 1 = 4$

$\chi^2_c \big|_{\alpha=0.05} = 9.488$

$\chi^2_c \big|_{\alpha=0.10} = 7.779$

Since, $\chi^2 > \chi^2_c$ i.e observed $\chi^2$ is more than both critical value, we can reject the null hypothesis. The Distribution significantly deviates from normal distribution at both 5% and 10% level of Significance.

4)

**Shipment A**

$\mu_A = 4.71$

$\sigma_A^2 = 0.01026$

**Shipment B**

$\mu_B = 4.74$

$\sigma_B^2 = 0.0056$

$F_{stat} = \sigma_A^2 / \sigma_B^2 = 1.8106$

$df_A = 12$

$df_B = 6$

$\alpha = 0.05$ : $F(df_A, df_B) = 4.00$

$\alpha = 0.10$ : $F(df_A, df_B) = 2.90$

$F < F_c(\alpha = 0.05), F_c(\alpha = 0.10)$

We fail to reject the A and B came Same population at both 5% and 10% Significance.

T test $(\sigma_A^2 \neq \sigma_B^2)$

$$t = \frac{\mu_A - \mu_B}{\sqrt{\frac{\sigma_A^2}{N_A} + \frac{\sigma_B^2}{N_B}}}$$

$= 0.634$

$$df = \frac{\left(\frac{\sigma_A^2}{N_A} + \frac{\sigma_B^2}{N_B}\right)^2}{\frac{\left(\frac{\sigma_A^2}{N_A}\right)^2}{N_A - 1} + \frac{\left(\sigma_B^2/N_B\right)^2}{N_B - 1}}$$

$= 15.863$

$$S = \sqrt{\frac{\sigma_A^2 N_A + \sigma_B^2 N_B}{N_A + N_B - 2}\left(\frac{1}{N_A} + \frac{1}{N_B}\right)}$$

$= 0.043$

$df_A \approx 16$

$t(\alpha = 0.05) = 0.69$

$t(\alpha = 0.10) = 1.746$

$t < t_c(\alpha = 0.05), t_c(\alpha = 0.10)$

We fail to reject the A and B came Same population at both 5% and 10% Significance.