1. A watch maker wanted to compare four robotic milling machines for cut roughness. The roughness is measured in microns (1/1000 of a mm). After milling a number of parts on each machine, he summarized the data in the following table.

Mach 1	Mach 2	Mach 3	Mach 4
$n_1 = 5$	$n_2 = 5$	$n_3 = 6$	$n_4 = 6$
$\bar{x}_1 = 11.5$	$\bar{x}_2 = 8.9$	$\bar{x}_3 = 9.3$	$\bar{x}_4 = 12.2$
$s_1 = 1.3$	$s_2 = 1.5$	$s_3 = 1.0$	$s_4 = 1.1$

Assume the roughness for Machine i follows a $N(\mu_i, \sigma_i^2)$ distribution, $i = 1, 2, 3, 4$, and assume that $\sigma_1 = \sigma_2 = \sigma_3 = \sigma_4$.

(a) Find the mean squares between groups, $MS(Between)$. *Show your work using clear notation.*

(b) Find the mean squares within groups, $MS(Within)$. *Show your work using clear notation.*

(c) Test $H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$ vs H_a : not H_0 at the $\alpha = 0.05$ significance level using a 3-step one-way ANOVA test. *Find the test statistic and critical value (use Matt's super sweet $F-$distribution web/phone app to find the critical value), plot the rejection region (be sure to label the distribution), and state your decision and final conclusion. Show your work using clear notation.*

(d) Find the $p-$value for the test in part (c). You will have to use the $F-$distribution web/phone applet to find the $p-$value. *Show your work using clear notation.*

(e) If we do Bonferroni pairwise comparisons, what significance level α^* should each test use? *Show your work using clear notation.*

(f) Perform the Bonferroni pairwise comparison $H_0 : \mu_3 = \mu_4$ versus $H_a : \mu_3 \neq \mu_4$ at the α^* significance level. *You must state the test statistic and critical value (use the web/phone $t-$distribution app to find the critical value), plot the rejection region (be sure to label your graph), and state your decision and final conclusion. Also, use the web/phone $t-$distribution app to find the $p-$value. Show your work using clear notation.*

(g) Write out H_0 and H_a for the remaining 5 Bonferonni pairwise comparisons.