Problem 1 (15 points) For the 118 students in this class, the correlation between the preferred age and number of Facebook friends is 0.21. Test the hypothesis that this correlation is significantly different from zero in the following steps. Use an alpha value of $\alpha = 0.01$.

a) (7 points) What is the critical value of $r$?

$df = 118 - 2 = 116$, Using table G and $df = 110$, the critical value of $r$ for a two-tailed test with $\alpha = 0.01$ is 0.242

b) (8 points) State the results of your hypothesis test in a complete sentence using APA format.

Our observed correlation of 0.21 falls outside the rejection region. We fail to reject $H_0$. The correlation between preferred age and number of Facebook friends is not significantly different from zero, $r(116) = 0.21, p > 0.01$. 
Problem 2  (40 points) Let’s test the hypothesis that preferred outdoor temperature differs with gender. Using the students in our class as a sample, the preferred outdoor temperature for the 92 female students has a mean of 70.71 degrees (F) and a standard deviation of 9.6608. The preferred outdoor temperature for 27 male students has a mean of 67.3 degrees (F) and a standard deviation of 13.6038. Test the hypothesis that the preferred outdoor temperature varies with gender. Use $\alpha = 0.05$.

a) (5 points) Calculate the pooled standard deviation ($s_p$).

Here are some mathematical facts, some of which are helpful:

$$\begin{align*}
(92)(9.6608)^2 + (27)(13.6038)^2 &= 13583.1683 \\
(92 - 1)(9.6608)^2 + (27 - 1)(13.6038)^2 &= 13304.7739 \\
sp &= \sqrt{\frac{(92-1)9.6608^2+(27-1)13.6038^2}{(92-1)+(27-1)}} = 10.6638
\end{align*}$$

b) (5 points) Calculate the pooled standard error of the mean ($s_{\bar{x}-\bar{y}}$)

Here are some mathematical facts, some of which are helpful:

$$\begin{align*}
\sqrt{\frac{1}{92} + \frac{1}{27}} &= 0.2189 \\
\sqrt{\frac{1}{89} + \frac{1}{24}} &= 0.2300 \\
s_{\bar{x}-\bar{y}} &= 10.6638 \sqrt{\frac{1}{92} + \frac{1}{27}} = 2.334
\end{align*}$$

c) (5 points) Calculate the t-statistic

$$t = \frac{\bar{x}-\bar{y}}{s_{\bar{x}-\bar{y}}} = \frac{70.71 - 67.3}{2.334} = 1.46$$

d) (5 points) Find the critical value of $t$.

For a two tailed test, $\alpha = 0.05$ and $df = 92 + 27 - 2 = 117$, $t_{crit} = \pm 1.98$ (using $df = 110$)
e) (10 points) State your decision in a complete sentence using APA format.

We fail to reject $H_0$. The preferred outdoor temperature for the female students ($M = 70.71$, $SD = 9.6608$) is not significantly different from the preferred outdoor temperature for the male students ($M = 67.3$, $SD = 13.6038$), $t(117) = 1.46$, $p > 0.05$.

f) (5 points) What is the effect size? Is it small, medium or large?

\[ d = \frac{|\bar{x} - \bar{y}|}{s_p} = \frac{|70.71 - 67.3|}{10.6638} = 0.32 \]

This is a small effect size.

g) (5 points) Use the appropriate power curve (provided at the end of this exam) to estimate the observed power of this test.

The observed power for two tailed test with an effect size of $d = 0.32$, $n = \frac{(92+27)}{2} = 60$ and $\alpha = 0.05$ is 0.4100.
Problem 3: (10 points) Suppose you conduct a t-test and get a p-value exactly equal to $\alpha = 0.01$.

a) (5 points) Where is your observed value of $t$ compared to the critical value of $t$?

The observed value of $t$, $t_{obs}$, will be equal to the critical value, $t_{crit}$.

b) (5pts) What is the observed power of this test?

If $t_{obs} = t_{crit}$, then the true distribution is centered on $t_{crit}$, so exactly half the true distribution lies above $t_{crit}$. This means that the power is equal to 0.5.

Problem 4 (10 points) Suppose you want to test the hypothesis that how you thought you’d do on Exam 1 varies with class rank. We have 47 Juniors and 66 Seniors in our class. The mean predicted Exam 1 scores for these students is shown in the bar graph below, where the error bars represent the standard error of the mean. If you were to run a one-tailed t-test for two independent means with $\alpha = 0.05$, circle the most likely decision:

Reject $H_0$

Fail to reject $H_0$
Problem 5 (25 points)

Let’s test the hypothesis that the correlation between UW GPA and high school GPA differs across students that chose ‘flight’ as their superpower and students that chose ’invisibility’ as their superpower. For the 68 students that chose ‘flight’ as their superpower in our class, the correlation between UW GPA and high school GPA is 0.44. For the 50 students that chose ‘invisibility’ as their superpower, the correlation is 0.09. Using an alpha value of $\alpha = 0.01$ are these correlations significantly different from each other? State your p-value to four decimal places and state whether or not you reject the null hypothesis. You don’t need to give your answer as a sentence or use APA format for this question.

Here are some mathematical facts, some of which are helpful:

Fisher’s z for $r = 0.44$ is 0.4722

Fisher’s z for $r = 0.09$ is 0.0902

$\sqrt{\frac{1}{65} + \frac{1}{47}} = 0.1915$

$\sqrt{\frac{1}{67} + \frac{1}{49}} = 0.188$

$z = \frac{0.4722 - 0.0902}{0.1915} = 1.9948$

$Pr(z) > 1.99 = 0.02305$

For a two-tailed test, we multiply this probability by two: $p = (0.02305)(2) = 0.0461$

We fail to reject $H_0$. 