Sample Second Midterm Exam

You must answer all the questions. The exam is closed book and closed notes.

**You must show your work to receive full credit**

1. We are interested in the relationship between how many times a year a person goes bowling and their score in a bowling tournament.

\[
\text{Score} = B_0 + B_1 \text{Day_bowl} + u
\]

a. Compute \( \hat{B}_0 \) and \( \hat{B}_1 \)

b. Compute \( se(\hat{B}_1) \)

c. Compute the \( R^2 \) for this regression

d. What would we expect a person who bowls 55 times a year to get in the tournament?

e. Will bowling one additional day per year necessarily change a bowler’s score by \( \hat{B}_1 \) on average? Why or why not?
2. We are studying the impact of law school characteristics on the starting salary of their graduates. We run the following regression of the median starting salary of the students on the median LSAT score of the graduating class, the Median college GPA of the class and the annual cost of the school and the rank of the school.

\[ \text{Log(salary)} = B_0 + B_1 \text{LSAT} + B_2 \text{GPA} + B_3 \text{log(Cost)} + u \]

a. Why do we expect \( B_1 \) to be positive?

b. Before looking at the regression results below what signs do you expect for \( B_2 \) and why?

We run the following regression in Stata

```
. reg lsalary lsat gpa lcost
```

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 137</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model</td>
<td>6.95187727</td>
<td>3</td>
<td>2.31729242</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>3.50026204</td>
<td>133</td>
<td>.02631776</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10.4521393</td>
<td>136</td>
<td>.076853965</td>
</tr>
</tbody>
</table>

| lsalary | Coef.    | Std. Err. | t    | P>|t| | [95% Conf. Interval] |
|---------|----------|-----------|------|-----|---------------------|
| lsat    | .016212  | .0055663  | XXXX| XXXX| XXXXXXXXX             |
| gpa     | .7038712 | .1174947  | XXXX| XXXX| XXXXXXXXX             |
| lcost   | .1592828 | .0436603  | XXXX| XXXX| XXXXXXXXX             |
| _cons   | 4.147906 | .5335527  | 7.77| 0.000| 3.092559             |

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c. State the null and alternative hypothesis then conduct a 1-sided t-test at the 5% level for the coefficient for \( B_2 \)?

d. Is \( B_2 \) practically significant?

e. State the null and alternative hypothesis then conduct a 2-sided t-test at the 5% level for the coefficient for \( B_3 \)?

f. Interpret the \( R^2 \) in this regression.
3. We are interested in athletes that are training for the long jump. We want to
determine if an extra hour of weight training during the week will improve a
persons’ long jump more than a 1 hour increase in weekly running time or if the
reverse is true. We run the following regression.

\[
\text{Long\_jump} = B_0 + B_1 \text{hrs\_lifting} + B_2 \text{hrs\_running} + u
\]

da. Please write out the null hypothesis in terms of Beta.

\[ H_0: \]

b. Please write out the alternative hypothesis for a two sided test

\[ H_A: \]

c. Please reformulate the regression above in terms of a new parameter \( \theta_1 \) so
that you can directly test the null hypothesis above using the regression
output.

\[ H_0: \]

\[ H_A: \]

\[
\text{Long\_jump} = B_0 + B_1 \text{hrs\_lifting} + B_2 \text{hrs\_running} + u
\]

d. Which parameter would you test to assess the null hypothesis and how
would you assess it at the 5% level for a two sided test with 190
observations?
4. We believe that the quality of a law school is the sole determinant of the median salary of the school's students. We run the following two regressions in Stata.

```
. reg lsalary lsat gpa lcost rank age libvol
```

```
Source |       SS       df       MS              Number of obs =      95
-------------+------------------------------           F(  6,    88) =   74.58
Model |  5.51709943     6  .919516572           Prob > F      =  0.0000
Residual |   1.0849829    88  .012329351           R-squared     =  0.8357
-------------+------------------------------           Adj R-squared =  0.8245
Total |  6.60208233    94  .070234918           Root MSE      =  .11104

------------------------------------------------------------------------------
  lsalary |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   lsat |   .0073895   .0053565     XXXX   XXXXX    XXXXXXXXX    XXXXXXXX
   gpa |   .2023062   .1122191     XXXX   XXXXX    XXXXXXXXX    XXXXXXXX
   lcost |   .0381755   .0388653     0.98   0.329    -.0390611    .1154122
      rank |  -.0029954   .0004408    -6.79   0.000    -.0038715   -.0021194
       age |   .0001788   .0003435     0.52   0.604    -.0005038    .0008614
   libvol |   .0002249   .0000724     3.11   0.003      .000081    .0003689
      _cons |   8.490009   .6957225    12.20   0.000     7.107407    9.872611
------------------------------------------------------------------------------
```

a. Test if LSAT is significant at the 5% level for a two sided t-test.

b. Test if GPA is significant at the 5% level for a one sided t-test.

```
. reg lsalary lcost rank age libvol if gpa ~= . & lsat ~= .
```

```
Source |       SS       df       MS              Number of obs =      95
-------------+------------------------------           F(  4,    90) =   96.29
Model |  5.35158918     4  1.3378973           Prob > F      =  0.0000
Residual |  1.25049315    90  .013894368           R-squared     =  0.8106
-------------+------------------------------           Adj R-squared =  0.8022
Total |  6.60208233    94  .070234918           Root MSE      =  .11787

------------------------------------------------------------------------------
  lsalary |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   lcost |   .0261753   .0354546     0.74   0.462    -.0442614     .096612
      rank |  -.0038553   .000395     -9.76   0.000     -.00464   -.0030707
       age |   .0001598   .0003642     0.44   0.662    -.0005637    .0008833
   libvol |   .0003134   .0000723     4.33   0.000      .0001697    .0004571
      _cons |  10.48072   .3562505    29.42   0.000     9.772964    11.18847
------------------------------------------------------------------------------
```

c. Use an F test to determine if LSAT and GPA are jointly significant
Useful Formulas

\[ \hat{B}_1 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \]

\[ \hat{B}_0 = \bar{y} - \hat{B}_1 \bar{x} \]

\[ se(\hat{B}_1) = \frac{\hat{\sigma}}{\left(\sum_{i=1}^{n} (X_i - \bar{X})^2\right)^{1/2}} \]

\[ \hat{\sigma}^2 = \frac{1}{n-2} \sum_{i=1}^{n} (y_i - \hat{B}_0 - \hat{B}_1 x_i)^2 \]

\[ R^2 = 1 - \frac{\hat{\sigma}^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2} \]