1. (45 Points) Suppose that you wish to predict wage outcomes via the following specification:

\[ \text{wage} = \beta_0 + \beta_{\text{drugs}} \text{drugs} + u \]

wage is measured in dollars per month, and drugs (taking on values from 0 to 7) is measured in days of hard drug use per week.

a.) Suppose you estimate \( \hat{\beta}_{\text{drugs}} = -100 \) and \( \hat{\sigma}_{\text{drugs}} = 5 \). What is the covariance between wages and drug use? (5 Points)

b.) Supposing again that \( \hat{\beta}_{\text{drugs}} = -100 \), and further, that \( \hat{\mu}_{\text{drugs}} = 1 \) and \( \hat{\mu}_{\text{wage}} = $2,000 \). What is the value of \( \hat{\beta}_0 \)? (5 points)
c.) Please state the Gauss-Markov assumptions (5 Points)

d.) “But Dr. Spearot, you should be taking logs of wages and drugs before running your regression. The coefficients from log-log regressions are much easier to interpret!!!” What is fundamentally wrong with this statement? (5 Points)

e.) In running the regression, I forgot to include crime, which is a variable measuring aggregate months spent in prison over the last 5 years. The variable crime is positively correlated with drugs and negatively correlated with wage. In what direction, if any, is the estimate \( \hat{\beta}_{\text{drugs}} \) biased? Supposing that the original estimate of \( \hat{\beta}_{\text{drugs}} \) is negative, what can be said about the sign of \( \beta_{\text{drugs}} \)? (5 Points)

f.) Suppose that, on average, somebody with drugs=0 has a positive predicted level of crime. Given the information in (e), in what direction, if any is \( \hat{\beta}_0 \) biased? Supposing that the original estimate of \( \hat{\beta}_0 \) is positive, what can be said about the sign of the true parameter \( \beta_0 \)? (5 Points)
g. Suppose that the variance of the unobservable is large when *drugs* is low or high, but small when *drugs* is in a mid-range. What kind of errors are these? (5 points)

h. I report that the $R^2$ for the above regression is 0.65. What does this say about the model? What does this not say about the model? (5 points)

i. Suppose that I double the size of the sample by replicating all observations once. Does anything related to the estimate $\hat{\beta}_{drugs}$ or its properties change? (5 points)
2. (25 Points) Using a sample of workers in California, I wish to estimate
\[
\log(\text{Wealth}) = \beta_0 + \beta_{educ} \cdot \text{educ} + \beta_{exper} \cdot \text{exper} + u
\]

Educ and Exper are measured in years and Wealth in thousands of dollars.

a.) Suppose you estimate that \( \hat{\beta}_{educ} = 0.2 \). Please interpret this estimate. (5 Points)

b.) Suppose that we have two individuals with the same predicted values of Wealth. The first individual has 12 years of education and 10 years of experience. The second individual has 15 years of education and 7 years of experience. Again assuming that \( \hat{\beta}_{educ} = 0.2 \), what is the estimate of \( \hat{\beta}_{exper} \)? (5 Points)

c.) Suppose that the true parameter \( \beta_{educ} \) actually equals 0.15. Given that \( \hat{\beta}_{educ} = 0.2 \), is this sufficient to conclude that there is a bias in the estimate \( \hat{\beta}_{educ} \)? If so, what kind of bias is this? If not, why? (5 Points)
d.) Suppose that instead of the above equation, I estimate the following:

\[ \text{Wealth} = \beta_0 + \beta_{\text{educ}} \log(\text{educ}) + \beta_{\text{exper}} \log(\text{exper}) + u \]

Please derive and interpret the coefficient on \( \log(\text{educ}) \) (10 Points)