1. Find $\hat{β}\_{0}$ and $\hat{β}\_{1}$ from data given in the table1. Interpret the results.

**(Table1)**

1. State the Ordinary Least Squares (OLS) estimation criterion. Derive the OLS slope estimator, $\hat{β}\_{1}$. Show each step of your work.
2. Derive Var($\hat{β}\_{1}$) (variance of the OLS slope estimator). Show each step of your work.
3. Find R2 from data given in the table. Explain your result.

**(Table 2)**

1. Briefly discuss any 3 of the Statistical Properties of OLS estimators.
2. Prove that when Gauss-Markov assumptions hold, the OLS slope estimator $\hat{β}\_{1}$ is an unbiased estimator of the population parameter, $β\_{1}$Show each step of your work.
3. Explain what is meant by each of the following statements about the estimator $\hat{θ}$ of the population parameter $θ$.
	1. $\hat{θ}$ is an unbiased estimator of $θ$
	2. $\hat{θ}$ is an efficient estimator of $θ$
	3. $\hat{θ}$ is an consistent estimator of $θ$
4. A researcher is using data for a sample of 25 business schools that offer MBA degrees to investigate the relationship between the annual salary gain of graduates Yi (measured in thousands of dollars per year) and annual tuition fees Xi (measured in thousands of dollars per year). Preliminary analysis of the sample data produces the following sample information:

N=25 $\sum\_{i=1}^{N}Y\_{i}=$ $\sum\_{i=1}^{N}X\_{i}=$ $\sum\_{i=1}^{N}Y\_{i}^{2}=$

$\sum\_{i=1}^{N}X\_{i}^{2}=$ $\sum\_{i=1}^{N}X\_{i}Y\_{i}=$ $\sum\_{i=1}^{N}x\_{i}y\_{i}=$

$\sum\_{i=1}^{N}y\_{i}^{2}=$ $\sum\_{i=1}^{N}x\_{i}^{2}=$ $\sum\_{i=1}^{N}\hat{y}\_{i}^{2}=$

Where $x≡X\_{i}-\overbar{X}$, $y≡Y\_{i}-\overbar{Y}$ and $\hat{y}≡\hat{Y}\_{i}-\overbar{Y}$.Use the above sample information to answer all the following questions. Show explicitly all formulas and calculations.

* 1. Use the above information to compute OLS estimates of the intercept coefficient $β\_{0}$ and slope coefficient $β\_{1}$.
	2. Interpret the slope coefficient estimate you calculated in part (a) -- i.e., explain in words what the numeric value you calculated for $\hat{β}\_{1}$ means.
	3. Calculate an estimate of $σ^{2}$, the error variance.
	4. Compute the value of $R^{2}$, the coefficient of determination for the estimated OLS sample regression equation. Briefly explain what the calculated value of $R^{2}$ means.

Hint: $\hat{β}\_{1}=\frac{\sum\_{}^{}(X-\overbar{X})(Y-\overbar{Y})}{\sum\_{}^{}(X-\overbar{X})^{2}}$ $\hat{σ}^{2}=\frac{RSS}{n-2}$ $R^{2}=\frac{ESS}{TSS}$

1. Briefly discuss any 4 of the Assumptions underlying OLS method.
2. Find $\hat{β}\_{0}$ and $\hat{β}\_{1}$ from data given in the table1. Interpret the results.

**(Table 1)**

1. Find R2 from data given in the table. Explain your result.

**(Table 2)**

1. You have been commissioned to investigate the relationship between annual R&D expenditures (Y) and total annual sales revenues (X) for chemical firms. You have assembled data for a sample of 32 chemical firms, where Yi is annual R&D expenditures of the i-th firm (measured in millions of dollars per year) and Xi is total annual sales revenues of the i-th firm (measured in millions of dollars per year). Preliminary analysis of the sample data produces the following sample information:

N=25 $\sum\_{i=1}^{N}Y\_{i}=$ $\sum\_{i=1}^{N}X\_{i}=$ $\sum\_{i=1}^{N}Y\_{i}^{2}=$

$\sum\_{i=1}^{N}X\_{i}^{2}=$ $\sum\_{i=1}^{N}X\_{i}Y\_{i}=$ $\sum\_{i=1}^{N}x\_{i}y\_{i}=$

$\sum\_{i=1}^{N}y\_{i}^{2}=$ $\sum\_{i=1}^{N}x\_{i}^{2}= $ $\sum\_{i=1}^{N}\hat{y}\_{i}^{2}=$

Where $x≡X\_{i}-\overbar{X}$, $y≡Y\_{i}-\overbar{Y}$ and $\hat{y}≡\hat{Y}\_{i}-\overbar{Y}$.Use the above sample information to answer all the following questions. Show explicitly all formulas and calculations.

* 1. Use the above information to compute OLS estimates of the intercept coefficient $β\_{0}$ and slope coefficient $β\_{1}$.
	2. Interpret the slope coefficient estimate you calculated in part (a) -- i.e., explain in words what the numeric value you calculated for $\hat{β}\_{1}$ means.
	3. Calculate an estimate of $σ^{2}$, the error variance.
	4. Compute the value of $R^{2}$, the coefficient of determination for the estimated OLS sample regression equation. Briefly explain what the calculated value of $R^{2}$ means.

Hint: $\hat{β}\_{1}=\frac{\sum\_{}^{}(X-\overbar{X})(Y-\overbar{Y})}{\sum\_{}^{}(X-\overbar{X})^{2}}$ $\hat{σ}^{2}=\frac{RSS}{n-2}$ $R^{2}=\frac{ESS}{TSS}$

1. Find $\hat{β}\_{0}$ and $\hat{β}\_{1}$ from data given in the table1. Interpret the results.

**(Table 1)**

1. *X* and *Y* are discrete random variables with the following joint distribution:

That is, Pr(*X* = 3, *Y* = 2) = 0.04, and so forth.

* 1. Calculate the probability distribution, mean, and variance of *Y*.
	2. Calculate the probability distribution, mean, and variance of Y given X=6
	3. Calculate the covariance and correlation between *X* and Y
1. *X* and *Y* are discrete random variables with the following joint distribution:

That is, Pr(*X* = 1, *Y* = 14) = 0.02, and so forth.

* 1. Calculate the probability distribution, mean, and variance of *Y*.
	2. Calculate the probability distribution, mean, and variance of Y given X=8
	3. Calculate the covariance and correlation between *X* and Y
1. Joint Distributions of Weather conditions and commuting times are presented in the table

Using the random variables *X* and *Y* from Table above, consider two new random variables *A* = 3 + 6*X* and *B* = 20 - 7*Y*. Compute

* 1. *E*(*A*) and E(B)
	2. $σ\_{A}^{2}$ and $σ\_{B}^{2}$
	3. $σ\_{AB}$ and corr(A,B)
1. Joint Distributions of Weather conditions and commuting times are presented in the table

Using the random variables *X* and *Y* from Table above, consider two new random variables *A* = 4 + 7*X* and *B* = 14 - 6*Y*. Compute

* 1. *E*(*A*) and E(B)
	2. $σ\_{A}^{2}$ and $σ\_{B}^{2}$
	3. $σ\_{AB}$ and corr(A,B)
1. Given the assumptions in column 1 of the table, show that the assumptions in column 2 are equivalent to them.

Assumptions of the classical model

1 2

E(Ui|Xi) = 0 E(Y|X) = $E\left(X\right)=β\_{0}+β\_{1}X$

Var(Ui|Xi) = $σ^{2}$ Var(Yi|Xi) = $σ^{2}$

1. Are the following models linear regression models? Why or why not?
	1. Models
2. Determine whether the following models are linear in the parameters, or the variables, or both. Which of these models are linear regression models?
	1. Models
3. Calculation of mean, variance and covariance of sum.
4. *X* and *Y* are discrete random variables with the following joint distribution:

(Table)

That is, Pr(*X* = 1, *Y* = 5) = 0.10, and so forth.

* 1. Calculate the probability distribution, mean, and variance of *Y*.
	2. Calculate the probability distribution, mean, and variance of Y given X=4
	3. Calculate the covariance and correlation between *X* and Y
1. Find R2 from data given in the table. Explain your result.

**(Table 2)**

1. Find $\hat{β}\_{0}$ and $\hat{β}\_{1}$ from data given in the table1. Interpret the results.

**(Table 1)**

1. Calculation of mean, variance and covariance of sum.
2. What is Central Limit Theorem? Why is it useful in Statistical Inference?
3. Based on sample sata, test if there is a significant relationship using t-test. Construct the hypotheses and show your calculations clearly. Use 5% significance level.
4. Given the following information, construct F-test and test the hypothesis:
5. Show that, F=t2. In which case is this equation true? Show each step of your work.
6. What is adjusted R2? How is it different from R2? Why is adjusted R2 useful? Briefly explain.
7. What is the Chow test and what is it used for? Show the necessary steps undertaken and formulate the test.
8. Question on confidence intervals.
9. Question on various functional forms of regression models.
10. What are the type I and type II errors? Is there a relationship between p-value and type I error? If yes, how?
11. Question on t-test. Calculation and interpretation.
12. Calculation on F-test. Use restricted/unrestricted models to underdate F-test.
13. Question on various functional forms of regression models.
14. Question on confidence intervals.
15. Question on F-test. Calculation and interpretation.
16. Question on t-test. Calculation and interpretation.
17. State with reason whether the following statements are true, false, or uncertain. Explain your answer.
18. Question on Chow test. Calculation and interpretation.
19. Question on confidence intervals. Calculation and interpretation
20. What is normality assumption and why is it important for hypothesis testing?
21. Question on t-test. Calculation and interpretation.
22. Question on F-test. Calculation and interpretation.
23. Question on confidence intervals.
24. Question on constructing confidence intervals and t-test.
25. Question on F-test. Calculation and interpretation.
26. Question on various functional form of regression model. T-testing.
27. What happens to the Unbiasedness property of OLS estimators when Heteroscedasticity exists? Do OLS estimates remain unbiased or not? Show your work.
28. What happens to the Efficiency property of OLS estimators when Heteroscedasticity exists? Do OLS estimates remain efficient or not? Show your work.
29. What happens to the Consistency property of OLS estimators when Heteroscedasticity exists? Do OLS estimates remain consistent or not? Show your work.
30. The relationship between Saving (S) and Income (I) is tested through 1950-2010 with the following model:

$$S= β\_{1}+β\_{2}I+u\_{i}$$

Using the dummy variable, test the presence of structural break in intercept in 1980. Construct the new model (the one with dummy), set the hypothesis and comment on the potential results of the test.

1. The relationship between Salary (S) and Education (E) is tested through 1970-2010 with the following model:

$$S= β\_{1}+β\_{2}E+u\_{i}$$

Using the dummy variable, test the presence of structural break in slope in 1985. Construct the new model (the one with dummy), set the hypothesis and comment on the potential results of the test.

1. The relationship between Investment (I) and Interest rate (R) is tested through 1940-1970 with the following model:

$$I= β\_{1}+β\_{2}R+u\_{i}$$

Using the dummy variable, test the presence of structural break both in slope and intercept (jointly) in 1960. Construct the new model (the one with dummy), set the hypothesis and comment on the potential results of the test.

1. What is the Weighted Least Squared (WLS) method and when is it used? Show how is it applied to the following model when population variance of error term ($σ\_{i}^{2}$) is known.

$$Y= β\_{1}+β\_{2}X+u\_{i}$$

1. Apply the Weighted Least Squared (WLS) method when your regression model has heteroscedasticity problem such that,

$Y= β\_{1}+β\_{2}X+u\_{i}$, $σ\_{i}^{2}=σ^{2}X\_{i}$

Show whether the error variance of weighted model becomes constant or not.

1. Apply the Weighted Least Squared (WLS) method when your regression model has heteroscedasticity problem such that,

$Y= β\_{1}+β\_{2}X+u\_{i}$, $σ\_{i}^{2}=σ^{2}X\_{i}^{2}$

Show whether the error variance of weighted model becomes constant or not.

1. Apply the Weighted Least Squared (WLS) method when your regression model has heteroscedasticity problem such that,

$Y= β\_{1}+β\_{2}X+u\_{i}$, $σ\_{i}^{2}=σ^{2}\hat{Y}\_{i}$

Show whether the error variance of weighted model becomes constant or not.

1. What is Breusch-Pagan test and what is used for? Briefly explain the steps undertaken in order to conduct the test (Show regressions, hypotheses, test-statistic etc.) and interpretation of the results.
2. What is White test and what is used for? Briefly explain the steps undertaken in order to conduct the test (Show regressions, hypotheses, test-statistic etc.)
3. What is autocorrelation? Briefly explain Cochrane-Orcutt two-step procedure in order to solve autocorrelation problem.
4. What is Durbin-Watson test and what is used for? Briefly explain the steps undertaken in order to conduct the test (Show regressions, hypotheses, test-statistic etc.) and interpretation of the results.
5. Problem on Durbin-Watson test
6. Problem on Durbin-Watson test
7. Problem on Durbin-Watson test
8. Problem on Durbin-Watson test
9. Problem on Breusch-Pagan test
10. Problem on Breusch-Pagan test
11. Problem on Breusch-Pagan test
12. Problem on Breusch-Pagan test
13. Problem on Breusch-Pagan test
14. Problem on Breusch-Pagan test
15. Problem on Breusch-Pagan test