

Math 222: Exam 2
Spring – 2017
04/12/2017
80 Minutes

Name: _____

Write your name on the appropriate line on the exam cover sheet. This exam contains 9 pages (including this cover page) and 4 questions. Check that you have every page of the exam. Answer the questions in the spaces provided on the question sheets. Be sure to answer every part of each question and show all your work. If you run out of room for an answer, continue on the back of the page — being sure to indicate the problem number.

Question	Points	Score
1	10	
2	5	
3	20	
4	15	
Total:	50	

1. (10 points) A group of researchers is trying to determine if there is a relationship between one's education level and whether one has found employment. They survey a group of individuals, asking whether they are employed full-time, part-time, or are unemployed. They also ask the individuals whether they have a high school education, some college education (Associates), a B.A., a Masters, or a Ph.D.. The results are summarized in Table 1 on the next page.
 - (a) Complete the missing entries in Table 1.
 - (b) Complete the missing entries in Table 2.
 - (c) Complete the missing entries in Table 3.
 - (d) State H_0 , H_a , and the degrees of freedom for this survey.
 - (e) Find the p -value and state the conclusion at $\alpha = 0.10$.

Table 1: Table of Counts for the Employment Survey.

	High School	Associates	B.A.	Masters	Ph.D.	Total
Full-Time	33	48	59	55	59	254
Part-Time	22		36	37	28	160
Unemployed	15	26	12	13	9	
Total	70	111	107	105	96	489

Table 2: Table of Expected Values for the Employment Survey.

	High School	Associates	B.A.	Masters	Ph.D.
Full-Time		57.66	55.58	54.54	49.87
Part-Time	22.90	36.32		34.36	31.41
Unemployed	10.74	17.02	16.41	16.10	14.72

Table 3: Table of Chi-Squared Contributions for the Employment Survey.

	High School	Associates	B.A.	Masters	Ph.D.
Full-Time	0.3105	1.6173	0.2106	0.0039	1.6735
Part-Time		0.0128	0.0280	0.2035	0.3704
Unemployed	1.6933		1.1856	0.5984	2.2252

2. (5 points) Cornaught University is investigating whether they are admitting under-represented groups 'fairly' or if income may have some influence in admittance. They collect family income data on all African-American students at the University. The breakdown of the students' income levels is given in the table below. Given that 22% of African-Americans make under 15K, 27% make between 15K and 35K, 38% make between 35K and 100K, 11% make between 100K and 200K, and 2% make over 200K, determine whether the students are being admitted 'fairly'. [Use $\alpha = 0.01$.]

Table 4: Breakdown of African-American students on family income.

Income Level	<15K	15K-35K	35K-100K	100K-200K	>200K
Number of Students	213	312	425	200	100

3. (20 points) A toy company has hired a group of statisticians to model their costs (in thousands of dollars) based on the number of items they make (in thousands of items). The statisticians use a computer system to create a linear model. The output of the computer program can be found on the next page.

- (a) Complete the missing entries in the computer printout of the model data below.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	_____	29886	_____	93.24	0.000
Items	_____	29886	_____	93.24	0.000
Error	_____	_____	320.5		
Total	24	37258			

Model Summary

S	R-sq	R-sq (adj)	R-sq (pred)
_____	80.21%	79.35%	75.27%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	113.91	6.95	_____	0.000	
Items	-9.589	0.993	-9.66	0.000	1.00

The regression equation is

production cost = _____

- (b) What was the total number of data values used to create the model?
- (c) What is the correlation coefficient? What is the coefficient of determination?

(d) What percentage of the variation in the costs is predicted by the variation in the items for this model?

(e) Construct a 95% confidence interval for β_1 .

(f) Test $H_0 : \beta_1 = 0$ versus $H_a : \beta_1 \neq 0$. Be sure to give the t -value, p -value, and the degrees of freedom. State the conclusion. Is the model linear?

4. (15 points) Concrete is a commonly used material in Civil Engineering. Compressive strength measures the ability of concrete materials to endure various strains. Researchers attempt to try to predict the Compressive strength of various mixtures of concrete using the cement amount, blast furnace slag, fly ash, water, superplasticizer, coarse aggregate, and fine aggregate used in the construction as well as the age of the concrete.¹ The model summary is given on the next page.

(a) Fill in the missing entries in the model on the next page.

(b) How many concrete mixtures were used to create the model?

(c) Test $H_0 : \beta_6 = 0$ versus $H_a : \beta_6 < 0$. Be sure to state the degrees of freedom, t -value, and p -value. [Use $\alpha = 0.05$.]

(d) If one re-ran the model using only the variables “FlyAsh”, “FineAg”, and “Age”, would these variables p -values change or remain the same? Explain.

¹I-Cheng, Yeh, “Modeling of strength of high performance concrete using artificial neural networks.”, *Cement and Concrete Research*, Vol. 28, No. 12, pp.1797–1808 (1998).

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	_____	176745	22093.1	204.27	0.000
Cement	_____	21533	21533.3	199.09	0.000
BF	_____	11353	11352.5	104.96	0.000
FlyAsh	_____	5281	5281.3	48.83	0.000
Water	_____	1513	1513.4	13.99	0.000
SP	_____	1046	1046.3	9.67	0.000
CoarseAg	_____	398	398.4	3.68	0.000
FineAg	_____	384	383.5	3.55	0.000
Age	_____	47905	47905.2	442.92	0.000
Error	_____	110428	108.2		
Total	1029	287173			

Model Summary

S	R-sq	R-sq (adj)	R-sq (pred)
_____	_____%	_____%	60.68%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-23.2	26.6	-0.87	0.384	
Cement	0.11979	0.00849	14.11	0.000	7.49
BF	0.1038	0.0101	_____	0.000	7.28
FlyAsh	0.0879	_____	6.99	0.000	6.17
Water	-0.1503	0.0402	-3.74	0.000	7.00
SP	0.2907	0.0935	3.11	0.002	2.97
CoarseAg	0.01803	0.00939	1.92	0.055	5.08
FineAg	_____	0.0107	1.88	0.060	7.01
Age	0.11423	0.00543	21.05	0.000	1.12

The regression equation is

Compression Strength = _____

Bonus (5 points): Below is a partial ANOVA table for a linear regression model.

ANOVA				
	DF	SS	MS	F
Regression		833		45.15
Residual		225		
Total	66	1058		

Find the degrees of freedom for the regression and the residual. You must show all the steps involved in your calculation.