École de gestion TELFER School of Management

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ADM 2304
APPLIED STATISTICAL METHODS IN BUSINESS

Midterm Exam – February 7, 2009

NAME (please print): _____

STUDENT NUMBER: _____

SECTION (please circle one): M N P Q R

Time allowed: **2 hours**
Question booklet: **5 pages (all single-sided sheets, including this cover sheet)**
Appendices: **2 pages plus 2 tables (on 2 double-sided sheets)**

Instructions:

1. Calculators, rulers, and one sheet of notes (8.5 x 11 in.) are allowed.
2. Please write clearly and legibly.
3. Statistical tables (z and t) are found following the appendices.
4. You must hand everything in at the end of the exam (exam question booklet, appendices and stat-tables). Please do not hand in your sheet of notes.

Question	Value	Mark
1	7	
2	7	
3	10	
4	6	
Total	**30**	

Statement of Academic Integrity

The School of Management does not condone academic fraud, an act by a student that may result in a false academic evaluation of that student or of another student. Without limiting the generality of this definition, academic fraud occurs when a student commits any of the following offences: plagiarism or cheating of any kind, use of books, notes, mathematical tables, dictionaries or other study aid unless an explicit written note to the contrary appears on the exam, to have in his/her possession cameras, radios (radios with head sets), tape recorders, pagers, cell phones, or any other communication device which has not been previously authorized in writing.

I have read the text on academic integrity and I pledge not to have committed or attempted to commit academic fraud in this examination.

Signed: _____

Question 1 [7 marks]

The number of withdrawals at a bank machine was monitored during randomly chosen 10 minute intervals over the past month. Appendix A gives the data distribution and various analyses.

a. You want to test whether the average number of withdrawals exceeds 3. Identify the most appropriate test, and explain briefly why you selected it.

[1]

b. Perform the hypothesis test that you selected above, using the 5% level of significance.

[3]

c. What is the approximate p-value of the test statistic?

[1]

d. Suppose you wanted to estimate the average number of withdrawals with a margin of error of ± 0.5 and a 95% confidence level. What sample size would be required?

[2]

Question 2 [7 marks]

An undercover investigative team decides to determine whether it costs more to have a moderately damaged car repaired at *Jo's Trusty Body Shop* or *Uncle Bob's Honest Collision Repairs.*.

a) Design an experiment and an appropriate hypothesis test that would *best* help answer this question. You may assume that the cost for fixing moderately damaged cars is normally distributed. Note that there are at least two types of experiments that would work here but one is clearly better than the other. Justify your choice.

[2]

b) The data collected are firm estimates (in thousands of dollars) from the two body shops:

7.1	7.9
9.0	10.1
11.0	12.2
8.9	8.8
9.9	10.4
9.1	9.8
10.3	11.7

The first column represents the estimates from *Jo's Trusty Body Shop* and the second column represents the estimates from *Uncle Bob's Honest Collision Repairs*. Perform the hypothesis test you determined was appropriate in part (a). Use a 5% significance level and state any additional assumptions required.

[4]

c) Explain what impact the normality assumption makes on your analysis and what you would do if you could not make this assumption. You do not need to do any calculations though!

[1]

Question 3. [10 marks]

Recent research in health sciences has shown that "Waist to Hip Ratio" (WHR) is an excellent indicator of the general health of an adult. It has been suggested that if the WHR of adult males is 0.9 or higher (0.8 or higher for adult females) the risk of morbidity increases significantly to "high".

In a random sample of 140 adult males, 56 were found to be "high risk" based on their WHR.

a. Test whether the data show that the proportion who are high risk is different from 30%. Use a 5% level of significance.

[3]

b. Find a 95% confidence interval for the proportion of adult males who are at high risk.

[2]

c. If we wanted to estimate the proportion of high risk adult males with a margin of error of ± 3%, what sample size should be used?

[2]

d. In another independent random sample of 8 adult males, there were no "high risk" individuals. Is this evidence sufficient to show that the proportion of high risk adult males is less than 30%? Perform the test using the .05 level of significance.

[3]

Question 4. [6 marks]

Two methods for etching semiconductor wafers are under consideration. The question is whether the etch rates of the two solutions are the same or not. Two random samples of size 100 were chosen and each sample was etched using one method. Appendix B shows a number of different Minitab outputs of *possible* tests for determining an answer to this question. Columns C1 and C2 represent method 1 and 2, respectively.

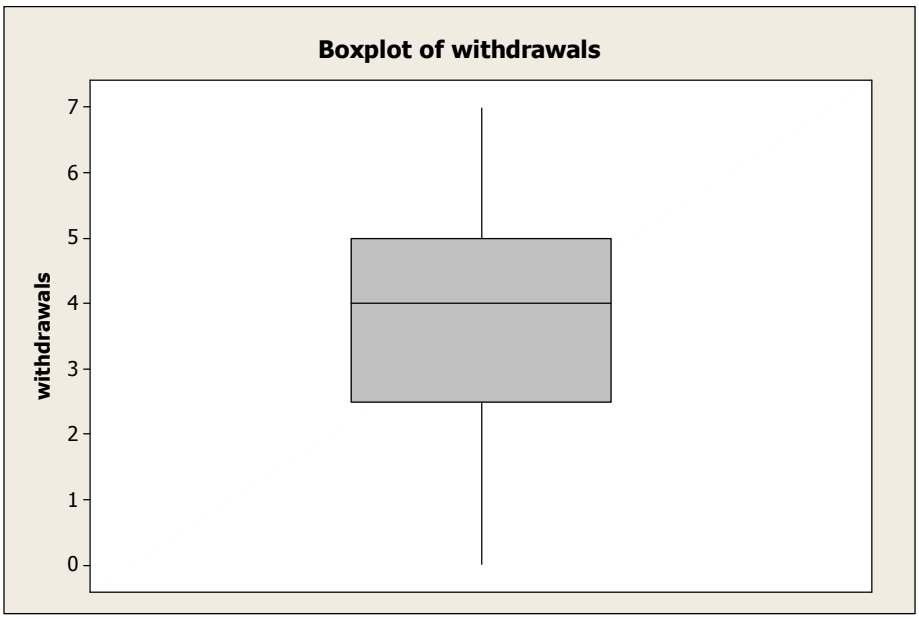
a. Choose the most appropriate test. Please explain why you chose the test you did over the other options.

[2]

b. Perform the test you selected above. Use the .01 level of significance.

[4]

Appendix A.



One-Sample T: withdrawals

```
Test of mu = 3 vs > 3

                                                    95%
                                                  Lower
Variable      N     Mean    StDev  SE Mean      Bound     T      P
withdrawals  25  3.76000  1.73877  0.34775  ________  ____  ____
```

One-Sample T: withdrawals

```
Test of mu = 3 vs not = 3

Variable      N     Mean    StDev  SE Mean         95% CI           T      P
withdrawals  25  3.76000  1.73877  0.34775  _____________  ____  ____
```

Wilcoxon Signed Rank Test: withdrawals

```
Test of median = 3.000 versus median not = 3.000

                   N
                 for   Wilcoxon         Estimated
             N  Test  Statistic      P     Median
withdrawals  25    20      158.5  0.048      4.000
```

Wilcoxon Signed Rank Test: withdrawals

```
Test of median = 3.000 versus median > 3.000

                   N
                 for   Wilcoxon         Estimated
             N  Test  Statistic      P     Median
withdrawals  25    20      158.5  0.024      4.000
```

Appendix B.

```
Two-sample T for C1 vs C2

     N    Mean  StDev  SE Mean
C1  100   9.95  0.417    0.042
C2  100  10.12  0.374    0.037


Difference = mu (C1) - mu (C2)
Estimate for difference:  -0.172000
99% CI for difference:  (     ,     )
T-Test of difference = 0 (vs not =): T-Value = ____  P-Value _______ DF = ____
Both use Pooled StDev = 0.3961


Two-sample T for C1 vs C2

     N    Mean  StDev  SE Mean
C1  100   9.95  0.417    0.042
C2  100  10.12  0.374    0.037

Difference = mu (C1) - mu (C2)
Estimate for difference:  -0.172000
99% upper bound for difference:  __________
T-Test of difference = 0 (vs <): T-Value = _____  P-Value _______  DF = _____

Paired T for C1 - C2

             N       Mean     StDev   SE Mean
C1          100     9.950    0.4167    0.0417
C2          100    10.1220    0.3743    0.0374
Difference  100  -0.172000  0.555429  0.055543


99% CI for mean difference: (      ,      )
T-Test of mean difference = 0 (vs not = 0): T-Value = ____ P-Value _____________



     N  Median
C1  100  10.000
C2  100  10.200

Point estimate for ETA1-ETA2 is -0.200
99.0 Percent CI for ETA1-ETA2 is (-0.300,0.000)
W = 8786.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is not significant at 0.0020
The test is significant at 0.0019 (adjusted for ties)
```

Standard Normal Distribution

$P(0 \le Z \le z)$

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000

Student's t distribution

t_α

$\alpha = P(t \geq t_\alpha)$

ν	0.250	0.200	0.150	**0.100**	0.075	**0.050**	0.030	**0.025**	**0.010**	**0.005**	**0.001**
1	1.00	1.38	1.96	3.08	4.17	6.31	10.58	12.71	31.82	63.66	318.31
2	0.82	1.06	1.39	1.89	2.28	2.92	3.90	4.30	6.96	9.92	22.33
3	0.76	0.98	1.25	1.64	1.92	2.35	2.95	3.18	4.54	5.84	10.21
4	0.74	0.94	1.19	1.53	1.78	2.13	2.60	2.78	3.75	4.60	7.17
5	0.73	0.92	1.16	1.48	1.70	2.02	2.42	2.57	3.36	4.03	5.89
6	0.72	0.91	1.13	1.44	1.65	1.94	2.31	2.45	3.14	3.71	5.21
7	0.71	0.90	1.12	1.41	1.62	1.89	2.24	2.36	3.00	3.50	4.79
8	0.71	0.89	1.11	1.40	1.59	1.86	2.19	2.31	2.90	3.36	4.50
9	0.70	0.88	1.10	1.38	1.57	1.83	2.15	2.26	2.82	3.25	4.30
10	0.70	0.88	1.09	1.37	1.56	1.81	2.12	2.23	2.76	3.17	4.14
11	0.70	0.88	1.09	1.36	1.55	1.80	2.10	2.20	2.72	3.11	4.02
12	0.70	0.87	1.08	1.36	1.54	1.78	2.08	2.18	2.68	3.05	3.93
13	0.69	0.87	1.08	1.35	1.53	1.77	2.06	2.16	2.65	3.01	3.85
14	0.69	0.87	1.08	1.35	1.52	1.76	2.05	2.14	2.62	2.98	3.79
15	0.69	0.87	1.07	1.34	1.52	1.75	2.03	2.13	2.60	2.95	3.73
16	0.69	0.86	1.07	1.34	1.51	1.75	2.02	2.12	2.58	2.92	3.69
17	0.69	0.86	1.07	1.33	1.51	1.74	2.02	2.11	2.57	2.90	3.65
18	0.69	0.86	1.07	1.33	1.50	1.73	2.01	2.10	2.55	2.88	3.61
19	0.69	0.86	1.07	1.33	1.50	1.73	2.00	2.09	2.54	2.86	3.58
20	0.69	0.86	1.06	1.33	1.50	1.72	1.99	2.09	2.53	2.85	3.55
21	0.69	0.86	1.06	1.32	1.49	1.72	1.99	2.08	2.52	2.83	3.53
22	0.69	0.86	1.06	1.32	1.49	1.72	1.98	2.07	2.51	2.82	3.50
23	0.69	0.86	1.06	1.32	1.49	1.71	1.98	2.07	2.50	2.81	3.48
24	0.68	0.86	1.06	1.32	1.49	1.71	1.97	2.06	2.49	2.80	3.47
25	0.68	0.86	1.06	1.32	1.49	1.71	1.97	2.06	2.49	2.79	3.45
26	0.68	0.86	1.06	1.31	1.48	1.71	1.97	2.06	2.48	2.78	3.43
27	0.68	0.86	1.06	1.31	1.48	1.70	1.96	2.05	2.47	2.77	3.42
28	0.68	0.85	1.06	1.31	1.48	1.70	1.96	2.05	2.47	2.76	3.41
29	0.68	0.85	1.06	1.31	1.48	1.70	1.96	2.05	2.46	2.76	3.40
30	0.68	0.85	1.05	1.31	1.48	1.70	1.95	2.04	2.46	2.75	3.39
31	0.68	0.85	1.05	1.31	1.48	1.70	1.95	2.04	2.45	2.74	3.37
32	0.68	0.85	1.05	1.31	1.47	1.69	1.95	2.04	2.45	2.74	3.37
33	0.68	0.85	1.05	1.31	1.47	1.69	1.95	2.03	2.44	2.73	3.36
34	0.68	0.85	1.05	1.31	1.47	1.69	1.95	2.03	2.44	2.73	3.35
35	0.68	0.85	1.05	1.31	1.47	1.69	1.94	2.03	2.44	2.72	3.34
36	0.68	0.85	1.05	1.31	1.47	1.69	1.94	2.03	2.43	2.72	3.33
37	0.68	0.85	1.05	1.30	1.47	1.69	1.94	2.03	2.43	2.72	3.33
38	0.68	0.85	1.05	1.30	1.47	1.69	1.94	2.02	2.43	2.71	3.32
39	0.68	0.85	1.05	1.30	1.47	1.68	1.94	2.02	2.43	2.71	3.31
40	0.68	0.85	1.05	1.30	1.47	1.68	1.94	2.02	2.42	2.70	3.31
50	0.68	0.85	1.05	1.30	1.46	1.68	1.92	2.01	2.40	2.68	3.26
100	0.68	0.85	1.04	1.29	1.45	1.66	1.90	1.98	2.36	2.63	3.17
200	0.68	0.84	1.04	1.29	1.45	1.65	1.89	1.97	2.35	2.60	3.13