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MID SEMESTER EXAMINATION - MARCH 2015

B. Tech. (BI) IV Semester

COURSE CODE: 10B12MA421 MAX. MARKS: 30

COURSE NAME: BIOSTATISTICS

COURSE CREDITS: V MAX. TIME: 2 HRS

Note: *Answer ALL three sections A, B and C in order. Show all calculations where applicable.*

Section A

(6x1 = 6 Marks)

1. Write the maximum likelihood estimator of σ ($SD\ of\ error$) in normal regression analysis. For the slope β in linear regression, write the standard error for estimate of slope **β**.
2. In simple linear regression $Y = \alpha + \beta X$, write the standard error for estimate of intercept α, *and* $\hat{Y}_{x_0}$ *(estimated value of* Y *at* $X = x_0$*)*.
3. Write the test statistics for **Sign test and Signed-rank** test for one sample. Which test is less wasteful and why?
4. Write the test statistics for **Kruskal-wallis** test. This test is nonparametric analog of which parametric test?
5. Write the test statistics for non-parametric analog for t-test (paired/dependent sample).
6. Write the test statistics **Wilcoxon–Mann–Whitney** test (**Mann–Whitney U test or Wilcoxon rank-sum test**).

Section B

7. The correlation coefficient in between the percent reduction in solids and percent reduction in chemical oxygen demand we observe for 28 samples is $r = 0.895$. Apply Fisher test and give inference for the null hypothesis $H_0: \rho = 0.5$ at $\alpha = 5\%$ level of significance where as $H_A: \rho > 0.5$. Find $p - value$ for this test and using this $p - value$ give inference for the same null hypothesis $H_0: \rho = 0.5\ vs\ H_A: \rho > 0.5$ at $\alpha = 1\%$ level of significance. **(3 Marks)**

8. Members of two species of antelopes (denoted as species A and B) are drinking along a river in the following order: ***A A B B A A B B B B A A A B B B B A A B B B***. Apply **run test for randomness** at **0.05** level of significance and test if the distribution of members of the two species along the river is random or not. Where as critical constants for $n_1 = 9, n_2 = 13, r_{0.025,9,13} = 6\ and\ r_{0.975,9,13} = 17$. Further using normalization for run test for randomness at **0.05** level of significance with two sided alternative. **(3 Marks)**

9. The data is the table below shows the duration of tolerance of pain by 11 mice before and after the administration of a drug (dose of adrenalin 0.04 mg/20 g body weight). Using **Wilcoxon Signed Ranked (WSR)** test, infer that whether the data provide sufficient evidence in support that the drug increases the duration of endurance of pain, i.e, test $H_0: M_a = M_b\ vs\ H_A: M_a > M_b$ Let $\alpha = 0.05$. **(3 Marks)**

Duration of Endurance of Pain	Before Drug (X_1)	15.5	12.7	14.8	16.7	20.1	22	20.2	18.1	17.6	17.4	19.1
	After Drug (X_1)	21.2	20.1	17.2	22.7	20	19.8	19.8	18.8	17.9	24.3	18.6

Section C

10. For the data set we are given $n = 10$, $\sum X = 306.8$, $\sum Y = 93.0$, $\sum X^2 = 9503.52$, $\sum Y^2 = 875.98$, $\sum XY = 2878.32$. Estimate slope of the linear regression model $Y = \beta_0 + \beta_1 X$. For $H_0: \beta_1 = 0$ vs $H_0: \beta_1 \neq 0$ draw inference at $\alpha = 5\%$ level of significance. Also find the **95% confidence interval**. From the inference of above hypothesis with the help of two sided 95% confidence interval draw inference for $H_0: \beta_1 = 1$ vs $H_0: \beta_1 \neq 1$. Given is $t_{8,0.025} = 2.306$. **(5 Marks)**

11. In a study of cerebrovascular disease, the patients from 3 socioeconomic backgrounds were thoroughly investigated. One characteristic measured was diastolic blood pressure in mm/Hg. Use the **Kruskal-wallis test** to infer at the $\mathbf{0.05}$ level of significance, whether the three groups differ with respect to this characteristic? Given critical value is $\chi^2_{0.05,\ 2} = \mathbf{5.99}$. **(4 Marks)**

Group A	100	103	89	78	105	
Group B	92	97	88	84	90	95
Group C	81	102	86	83	99	

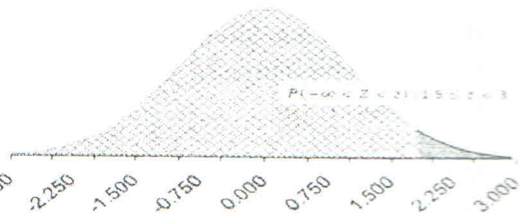
12. A set of experimental runs was made to determine a way of predicting coking time Y at various level of oven width x_1, and flue temperature x_2. Summarizing the coded data as; $n = 8$, $\sum X_1 = 25$, $\sum X_2 = 16$, $\sum Y = 6370$, $\sum X_1 Y = 20311$, $\sum X_1^2 = 87$, $\sum X_1 X_2 = 55$, $\sum X_2 Y = 12977$, $\sum X_2^2 = 36$, $\sum Y^2 = 5090708$. ***Using matrix notations approach*** for the multiple linear regression equation $\boldsymbol{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2}$ as $Y = X\,\mathrm{B}$: Test the hypothesis at 5% level by analysis of variance (ANOVA) for regression, that there is no significant multiple regression relationship *i.e*, $\boldsymbol{H_0\!: \beta_0 = \beta_1 = \beta_2 = 0}$. **Make ANOVA table** and infer using critical value $F_{0.05\,(2,5)} = 5.786$. **(3.5 Marks)**

13. Next, for the same data summary provided in **Problem 12**, using matrix notations approach for the multiple linear regression equation $\boldsymbol{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2}$ as $Y = X\,\mathbf{B}$ and **MLE of σ** obtained therein, for the given critical value $t_{0.05\,(5)} = 2.015$ test the hypothesis at 5% $\mathbf{H_0\!: \beta_1 = 35}$ **vs** $\mathbf{H_A\!: \beta_1 > 35}$. **(2.5 Marks)**

Standard Normal Probability Points

P(Z<z) for 0<=z<3

P(-infty<Z<z) for 0<=z<3



Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.500	0.504	0.508	0.512	0.516	0.520	0.524	0.528	0.532	0.536
0.1	0.540	0.544	0.548	0.552	0.556	0.560	0.564	0.567	0.571	0.575
0.2	0.579	0.583	0.587	0.591	0.595	0.599	0.603	0.606	0.610	0.614
0.3	0.618	0.622	0.626	0.629	0.633	0.637	0.641	0.644	0.648	0.652
0.4	0.655	0.659	0.663	0.666	0.670	0.674	0.677	0.681	0.684	0.688
0.5	0.691	0.695	0.698	0.702	0.705	0.709	0.712	0.716	0.719	0.722
0.6	0.726	0.729	0.732	0.736	0.739	0.742	0.745	0.749	0.752	0.755
0.7	0.758	0.761	0.764	0.767	0.770	0.773	0.776	0.779	0.782	0.785
0.8	0.788	0.791	0.794	0.797	0.800	0.802	0.805	0.808	0.811	0.813
0.9	0.816	0.819	0.821	0.824	0.826	0.829	0.831	0.834	0.836	0.839
1.0	0.841	0.844	0.846	0.848	0.851	0.853	0.855	0.858	0.860	0.862
1.1	0.864	0.867	0.869	0.871	0.873	0.875	0.877	0.879	0.881	0.883
1.2	0.885	0.887	0.889	0.891	0.893	0.894	0.896	0.898	0.900	0.901
1.3	0.903	0.905	0.907	0.908	0.910	0.911	0.913	0.915	0.916	0.918
1.4	0.919	0.921	0.922	0.924	0.925	0.926	0.928	0.929	0.931	0.932
1.5	0.933	0.934	0.936	0.937	0.938	0.939	0.941	0.942	0.943	0.944

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
1.5	0.933	0.934	0.936	0.937	0.938	0.939	0.941	0.942	0.943	0.944
1.6	0.945	0.946	0.947	0.948	0.949	0.951	0.952	0.953	0.954	0.954
1.7	0.955	0.956	0.957	0.958	0.959	0.960	0.961	0.962	0.962	0.963
1.8	0.964	0.965	0.966	0.966	0.967	0.968	0.969	0.969	0.970	0.971
1.9	0.971	0.972	0.973	0.973	0.974	0.974	0.975	0.976	0.976	0.977
2.0	0.977	0.978	0.978	0.979	0.979	0.980	0.980	0.981	0.981	0.982
2.1	0.982	0.983	0.983	0.983	0.984	0.984	0.985	0.985	0.985	0.986
2.2	0.986	0.986	0.987	0.987	0.987	0.988	0.988	0.988	0.989	0.989
2.3	0.989	0.990	0.990	0.990	0.990	0.991	0.991	0.991	0.991	0.992
2.4	0.992	0.992	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.994
2.5	0.994	0.994	0.994	0.994	0.994	0.995	0.995	0.995	0.995	0.995
2.6	0.995	0.995	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996
2.7	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
2.8	0.997	0.998	0.998	0.998	0.998	0.998	0.998	0.998	0.998	0.998
2.9	0.998	0.998	0.998	0.998	0.998	0.998	0.998	0.999	0.999	0.999
2.9	0.998	0.998	0.998	0.998	0.998	0.998	0.998	0.999	0.999	0.999

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