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University Examinations 2011/2012

FIRST YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE IN APPLIED STATISTICS

STA 3101: MULTIVARIATE ANALYSIS

DATE: JANUARY 2012 **TIME: 3 HOURS**

INSTRUCTIONS: *Answer Question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

a) Outline the characteristics of multivariate cumulative distribution functions,(5 Marks)
b) Let $\underline{X} = (x_1, x_{2,} x_3, x_4)'$ be a multivariate normally distributed random vector with the mean vector $\underline{\mu}$ and variance covariance matrix $\sum$. Consider the partition $\underline{X} = (\underline{X}_1, \underline{X}_2)'$ on random vector; where $\underline{X}_1 = (x_1, x_{2,})'$ and $\underline{X}_2 = (x_3, x_4)'$. Find the conditional expectation $E((\underline{X}_1 | \underline{X}_2)$. (4 Marks)
c) Show that a p-dimensional random vector $\underline{X}$ has a p-variate normal distribution if and only if $y = \underline{a}' \underline{X} \sim N(\underline{a}' \underline{\mu}, \underline{a}' \sum \underline{a})$ where $\underline{a}' \neq 0$. (4 Marks)
d) Discuss some of the methods used to decide on which principal component to be retained for analysis. (7 Marks)
e) Describe the relationship between the Hotteling T2 distribution and the F distribution. (5 Marks)
f) With $A_{q\times p}$ being a matrix of consonants and $b_{q\times 1}$ vector of constants, find an expression of the variance of $A\underline{x} + \underline{b}$. (5 Marks)

QUESTION TWO (20 MARKS)

a) Define the density function of a p-dimensional random vector $\underline{X}$ which is normally distributed with mean $\underline{\mu}$ and variance $\sum$. (2 Marks)
b) Derive an expression for the density when $p = 2$. (9 Marks)

c) Let $\underline{y} = \Sigma^{-\frac{1}{2}}(\underline{X} - \underline{\mu})$. Find an expression for the distribution of $\underline{y}$. (9 Marks)

QUESTION THREE (20 MARKS)

a) Let $\underline{X}_1, \underline{X}_2, \ldots, \underline{X}_n$ be p-variate random vectors from a distribution with mean $\underline{\mu}$ and variance Σ. Find the unbiased estimators of the sample mean vector and variance. (9 Marks)

b) Let $X_{n\times p}$ be a data matrix from $N_p(0, \Sigma)$and $V = X'X = \sum_{i=1}^{P} \underline{X}_i \underline{X'}_i$.

   i. Find an expression for the distribution of V.

   ii. Derive the characteristic function of V. (11 Marks)

QUESTION FOUR (20 MARKS)

Describe mathematically, how the principal components are derived.

(20 Marks)