Applied Statistics Qualifier Examination
(Part II of the STAT AREA EXAM)

May 28, 2025; 11:00AM-1:00PM EST

General Instructions:

(1) The examination contains 4 Questions. You are to **answer 3 out of 4** of them. *** Please only turn in solutions to 3 questions ***

(2) You may use up to 4 books and 4 class notes, plus your calculator and the statistical tables.

(3) NO computer, internet, cell phone, or smart watch is allowed.

(4) ***This is a 2-hour exam*** **11:00am- 1:00 PM – Please turn in by 1:00pm**.

Please be sure to fill in the appropriate information below:

I am submitting solutions to QUESTIONS _____, _____, and _____ of the applied statistics qualifier examination. Please put your name on every page of your exam solutions, and add page number for solutions to each question individually.

There are _____ pages of written solutions.

Please read the following statement and sign below:

Academic integrity is expected of all students at all times, whether in the presence or absence of members of the faculty. Understanding this, I declare that I shall not give, use, or receive unauthorized aid in this examination.

_____
(Signature)

_____
(Name)

_____
(SBU ID)

Name: _____ Signature: _____

1. A researcher conducts an experiment to test the effects of four different diets (A, B, C, D) on cholesterol levels. Each diet group has 20 participants. The researcher wishes to test the following specific hypotheses simultaneously:

$H_{01}: \mu_A - \mu_B$
$H_{02}: \mu_C - \mu_D$
$H_{03}: 1/2(\mu_A + \mu_B) - 1/2(\mu_C + \mu_D)$

Here is the summary statistics of the 4 groups.

Group	Sample size	Sample mean	Sample variance
A	20	203.9	1566.7
B	20	223.4	1182.8
C	20	197.8	1136.6
D	20	208.7	1243.3

(a) Are these hypotheses pairwise orthogonal? Justify your answer.

(b) Test these hypotheses at an overall significance level 0.05.

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2. Data from two clinical trials are provided in Table below.

Clinical Trial	Intervention Group	Number of Strokes	Follow-up (Person-Years)
1	Anticoagulant (A)	$Y_{1A} = 4$	$P_{1A} = 456$
	Control (C)	$Y_{1C} = 19$	$P_{1C} = 440$
2	Anticoagulant (A)	$Y_{2A} = 6$	$P_{2A} = 237$
	Control (C)	$Y_{2C} = 9$	$P_{2C} = 242$
Total	Anticoagulant (A)	$Y_{.A} = 10$	$P_{.A} = 693$
	Control (C)	$Y_{.C} = 28$	$P_{.C} = 682$

These trials examined the effect of anticoagulant treatment for the prevention of stroke in patients with valvular atrial fibrillation.

(a) Construct a test of the null hypothesis that the true effect of intervention is the same for both clinical trials (i.e. H_0: No interaction between treatment group and clinical trial). Clearly state any assumptions you have made. Briefly summarize the results of your analysis.

(b) Test whether the anticoagulant treatment has any effect on the prevention of stroke. Provide a brief justification and summary of your analysis.

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3. Consider the linear model

$$y = X\beta + \varepsilon$$

X is $n \times p$ of rank p, and $\varepsilon \sim N(0, \sigma^2 I_n)$. Let $\phi_1 = a_1'\beta$ and $\phi_2 = a_2'\beta$ be two given linear function of β. Show how to obtain the $(1-\alpha)100\%$ confidence interval on $\psi = \frac{\phi_1}{\phi_2}$.

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4. Consider the VAR (1) model:

$$\begin{pmatrix} Y_{1,t} \\ Y_{2,t} \end{pmatrix} = \begin{bmatrix} 1.1 & -0.3 \\ 0.6 & 0.2 \end{bmatrix} \begin{pmatrix} Y_{1,t-1} \\ Y_{2,t-1} \end{pmatrix} + \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{pmatrix},$$

$$\text{where } \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{pmatrix} \overset{i.i.d.}{\sim} \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 5 & -2 \\ -2 & 4 \end{bmatrix} \right)$$

(a) Which VAR form, structural or reduced form, is the above model? Please transform this model to the other form. That is, if the above is a structural form, please transform it to the reduced form, and vice versa. Please report the variance-covariance matrix, Σ, of the error term of the other form derived too.

(b) Is this VAR(1) series stationary? Please show the entire derivation.

(c) Please derive the marginal series of this VAR(1). Please identify what time series models these marginal series are.