## Question 1

Each of the figures below shows the comparison of the means of a measured value of two groups.

Figure I


Error bars show S.D.

Figure II


Error bars show 95\% Cl of Mean

Figure III


Error bars show SEM
A) In Figure I, do the means of A and B show a statistically significant difference (use 95\% confidence)? Explain your reasoning.
B) In Figure II, do the means of C and D show a statistically significant difference (use 95\% confidence)? Explain your reasoning.
C) In Figure III, do the means of E and F show a statistically significant difference (use 95\% confidence)? Explain your reasoning.
D) Explain the difference between statistical significance and clinical or scientific significance.

Name:

## Question 2

Explain the difference between a prospective and a retrospective study. What are the advantages and disadvantages of a retrospective study?

## Question 3

The figure below was generated in R by fitting a dataset of 45 ( $\mathrm{x}, \mathrm{y}$ ) points to a linearized model of the equation $y=\alpha \cdot x^{\beta} \cdot e^{-x / \gamma}$. The black curve shows values for $y$ predicted by the linearly regressed model (using the predict function). The red curves were generated using the predict function with the argument interval=' $c^{\prime}$, and the blue curves were generated using the predict function with the argument interval=' $\mathrm{p}^{\prime}$.

A) Transform the model equation above into a form suitable for linear regression.
B) Explain the meaning of the envelope defined by the red (inner) curves.
C) Explain the meaning of the envelope defined by the blue (outer) curves.
D) What would you expect to happen to the area of the red (inner) envelope if additional data were collected and the model was re-fit with $\mathrm{n}=450$ ?
E) What would you expect to happen to the area of the blue (outer) envelope if additional data were collected and the model was re-fit with $\mathrm{n}=450$ ?
F) Explain the difference between linear and non-linear regression. What are the advantages and disadvantages of each?

## Question 4

A linear difference model in two variables, $x$ and $y$, has eigenvalues...

$$
\begin{gathered}
\lambda_{1}=1.5 \\
\lambda_{2}=-0.5
\end{gathered}
$$

...and corresponding eigenvectors...

$$
v_{1}=\binom{1}{1} \quad v_{2}=\binom{1}{-1}
$$

Take the initial condition for this model to be $\mathrm{x}=32, \mathrm{y}=0$.
A) Write expressions for $x_{t}$ and $y_{t}$ in terms of $t$.
B) What can you say about the long-term behavior of the system?
C) Sketch the first four steps of the evolution of the system.

(just another blank grid in case you need it)

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## Question 5

A new planet has been discovered in a far off galaxy primarily dominated by Borg inhabitants. Human and Vulcan scientists have been studying the planet and have made several interesting observations. The planet seems to switch between looking BLUE on some days and RED on others. The scientists have also determined, by studying data each day over a long time period, that when the planet is BLUE, there is an $80 \%$ chance that it will be blue the next day. When the planet is RED, there is also an $80 \%$ chance it will be blue the next day.
A) What is the Markov Property?
B) Draw the Markov chain describing the system with states and probability transitions.
C) If the planet is Red today, use your model to predict what it look like for the next 3 days?

