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Name:

Each of the multiple choice questions below has one correct choice. Circle the correct choice.

Q1

An SIR model for a system is created and described by the following equations.

$$S' = \alpha S - \beta S - \gamma S I$$
$$I' = \gamma S I - \beta I - \delta I$$
$$R' = \delta I - \beta R - \rho R$$

A mask program is introduced which significantly reduces the probability of infection per encounter. Which of the coefficients above is likely to decrease?



$\mathbf{Q2}$

A 3-dimensional vector field is described by the following equations.

$$X' = X - Y$$
$$Y' = Y - Z$$
$$Z' = Z - X$$

(For example, the change vector at the point (10, 1, 0) is (9, 1, -10)). Which of the following statements regarding the vector field above is false? (-(, 1, 0)) $\xrightarrow{\ell}$ (-(, 1, 0)) (-(, 1, 0)) (-(, 1, 0)) (-(, 1, 0)) (-(, 1, 0)) (-(, 1, 0))

(i) The change vector at the point (1,0,0) and the change vector at the point (-1,0,0)have opposite directions. (i) The change vector at the point (1,1,1) is a zero vector. (c) The change vector at the point (0,1,0) is a unit vector.

1

 $(-1,1,0) \xrightarrow{l} 52. \neq 1$

$\mathbf{Q3}$

The population of a feral buffalo herd in Australia¹ is found to be described by

$$P' = P^2 - 4P.$$

At time t = 4 the population is 5. Euler's method is used to estimate the population at time t = 6 using the interval $\Delta t = 1$. This estimate is:



A line in the xy-plane with slope 5 passes through the points (3,2) and (1,m). The value of m is:

(a) -8
(b) -4
(c) 4
(d) 8

$$5 = \frac{2 - m}{2} \rightarrow 10 = 2 - m$$

$$8 = -m$$

$$= m = -8$$

2

¹Yes, they were a serious problem in Australia in the 20th century.

$\mathbf{Q5}$

The state space trajectory of a system with variables M, N is shown below. Assuming that as time increases *the trajectory goes in a counterclockwise direction*, which of the following graphs is a possible time-series of the trajectory? (Note: in the time-series graphs, the horizontal axis represents time.)

