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## Nonlinear Dynamics: Mathematical and Computational Approaches

Lead instructor: Liz Bradley

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Quiz scores are NOT recorded.

- You may come back to quizzes and take them as many times as you like
- When you are finished, clicking the "Score" button at the bottom of the test will show you the correct responses.

### Question 1

Smale's horseshoe is a map of the unit square into itself (experts: assume that any region of the plane can be continually deformed to the unit square).

- ☒ A. True
- ☐ B. False

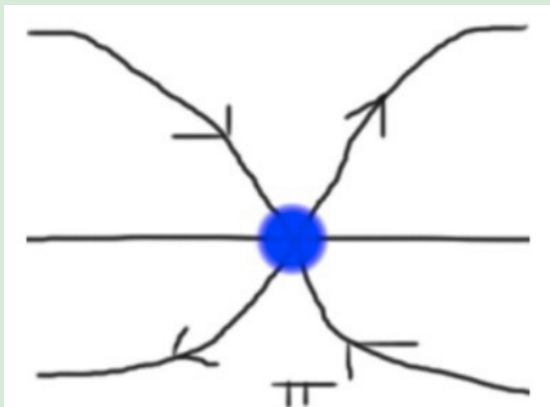
### Question 2

Smale's horseshoe maps some close points far apart (& vice-versa).

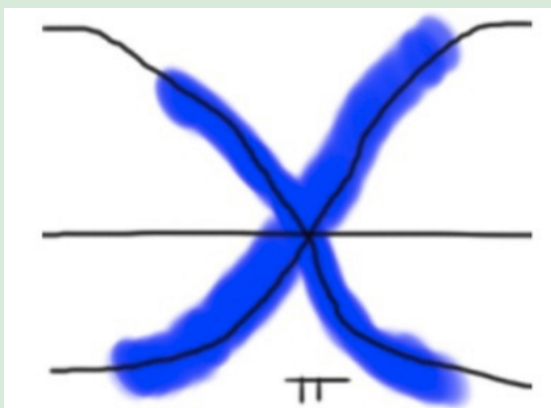
- ☒ A. True
- ☐ B. False

### Question 3

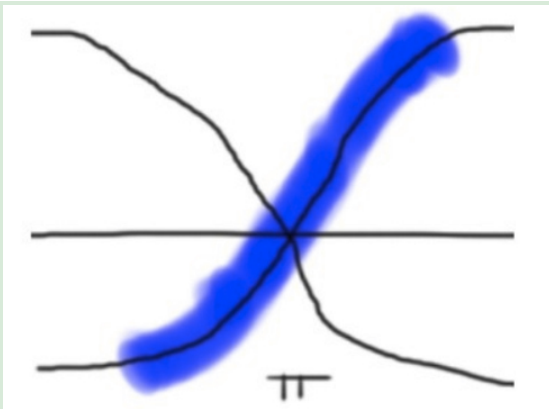
The following picture shows a ball of initial conditions (blue) around the saddle point  $\Theta = \pi$  in the undamped pendulum. The stable and unstable manifolds are drawn in. (Experts: assume this ball starts in a very tight cluster around  $\Theta = \pi$ )



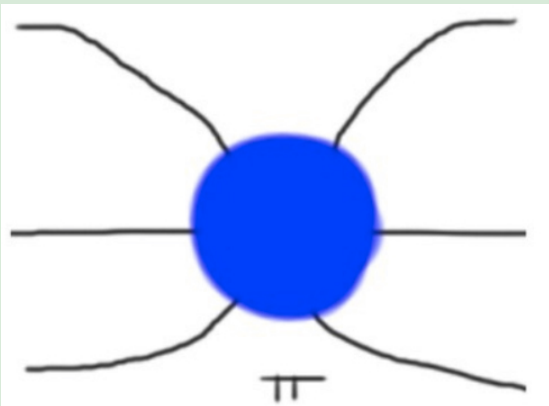
Which of the following *sketches* below shows the *general* shape of that ball of initial conditions, evolved forward in time?

☐


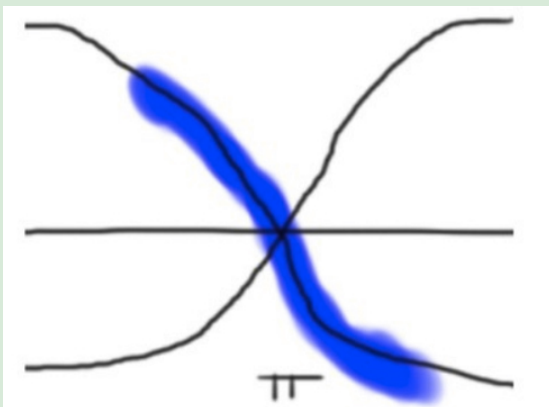
A.



B.



C.



D.

☐ E. All of the above, depending on the damping term.

#### Question 4

Horseshoes:

(a)

Only turn up in the dynamics of the Smale horseshoe map

- ☐ A. True  
☒ B. False

(b)

are important because they play a role in proofs of chaos

- ☒ A. True  
☐ B. False

(c)

turn up in the dynamics of the pendulum

- ☒ A. True  
☐ B. False

## Question 5

Dissipation is a necessary condition for the existence of attractors.

☐ A. True

☒ B. False

You got 6 out of 7 questions correct

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