

Name: \_\_\_\_\_

VIP ID: \_\_\_\_\_

- Write your name and your VIP ID in the space provided above.
- The test has six (6) pages, including this one and one page of scratch paper at the end.
- **Do not answer** any problem in the scratch paper. All solutions must be provided on pages 2–5 where it proceeds.
- Show sufficient work to justify all answers unless otherwise stated in the problem. Correct answers with inconsistent work may not be given credit.
- Credit for each problem is given at the right of each problem number.

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Page	Max	Points
2	15	
3	15	
4	20	
5	20	
6	10	
7	20	
<b>Total</b>	100	

**Problem 1** (15 pts—5 pts each part). A body with mass 0.5 kg is attached to the end of a spring that is stretched 2 m by a force of 100 N. It is set in motion one meter to the right, and moving to the left at that time with an initial velocity of 5 m/s.

(a) Find the position function of the body.

$$x(t) =$$

(b) Indicate the amplitude, frequency, period of oscillation and time lag of this motion.

Amplitude:

Frequency:

Period:

Time lag:

(c) Sketch the solution curve. Make sure to label all relevant information (amplitude, time lag and period).

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(b) Sketch the solution curve. Indicate clearly how far the mass moves to the right before starting back toward the origin (show all necessary work to find this value)

$$x(t) =$$

**Problem 5** (10 pts). Consider a damped forced motion with equation

$$x'' + 2x' + 9x = 80 \cos 5t.$$

Find  $x(t)$  if  $x(0) = x'(0) = 0$ . Sketch the graph of the motion for  $t \in$

$x(t) =$

**Problem 6** (20 pts—10 pts each). Consider an undamped forced motion with equation

$$x'' + 9x = 30 \cos 3t.$$

(a) Assume  $m = 1$ . Find the values of  $k$ ,  $F_0$  and  $\omega$ .

$$k =$$

$$F_0 =$$

$$\omega =$$

(b) Find  $x(t)$  if  $x(0) = x'(0) = 0$ .

$$x(t) =$$