

**Institute of Applied Mechanics and Mechatronics  
Slovak University Technology in Bratislava**

## **Assignment 2**

**Investigation of the system response**

**Name and Surname:**

**Group:**



## Assignment 2

### ASSIGNMENT:

Let us consider the given system according your variant. Derive the differential equations for given system if you know the inputs given by following Tab.

Tab. Input parameters of mechanical system

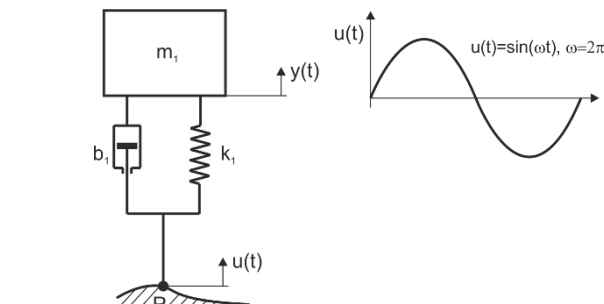
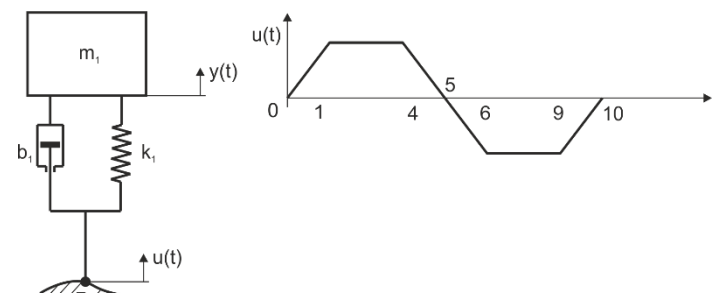
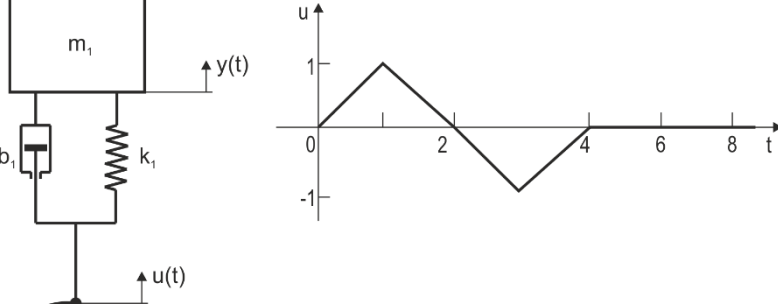
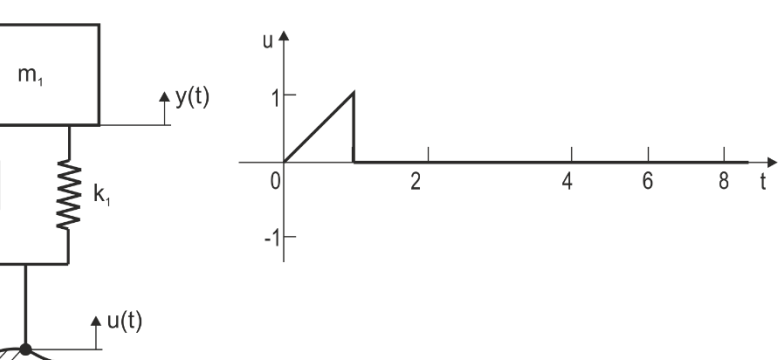
$m_1$ [kg]	$m_2$ [kg]	$k_1$ [N.m <sup>-1</sup> ]	$k_2$ [N.m <sup>-1</sup> ]	$b_1$ [N.s.m <sup>-1</sup> ]	$b_2$ [N.s.m <sup>-1</sup> ]	$f$ [Hz]	FO [N]
3	5	1000	1500	10	15	10	100

### Then complete following tasks of the assignment

1. Find the transfer function of the system
2. Investigate the response of a given system using the Laplace transform method for **unity step input  $u(t)=1$**  analytically. And compare the obtained solution with the response calculated by command **step** in Matlab.
3. Using suitable commands of Matlab create the Matlab script for obtaining the response of your system for the arbitrary signal according your variant. Calculate the response of your system using command **lsim**.
4. Display the solution on two kinds graphs one above one where the first one displays the forcing **input signal  $u(t)$**  and the second one displays the **output signal  $y(t)$** .

# Assignment 2

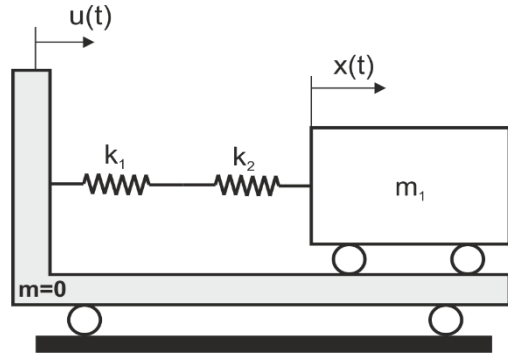
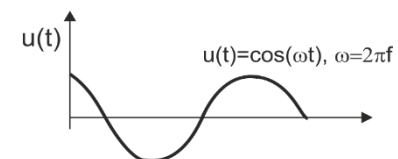
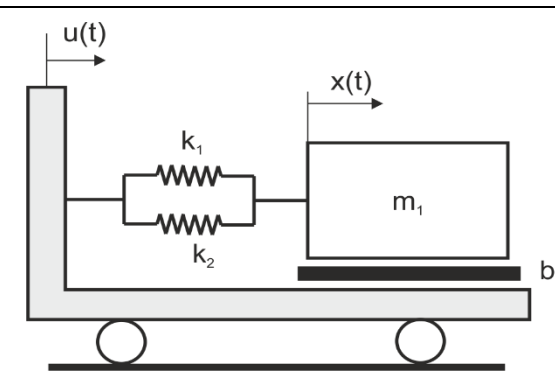
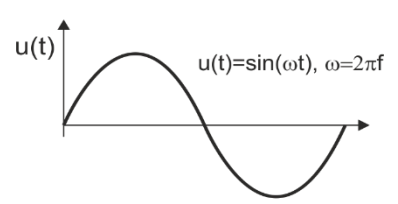
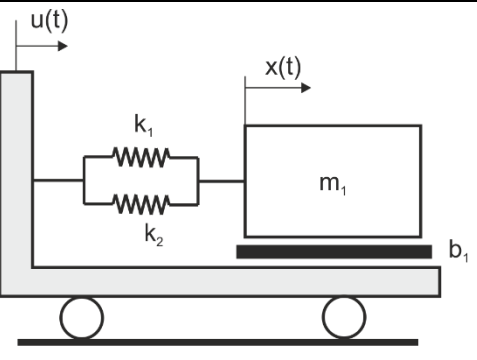
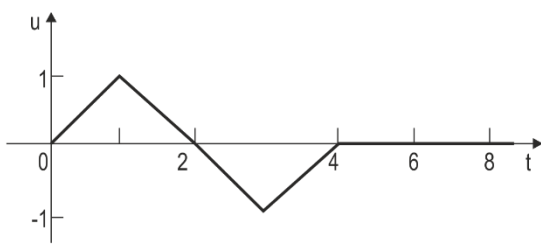
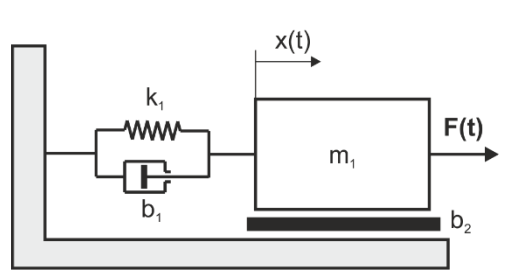
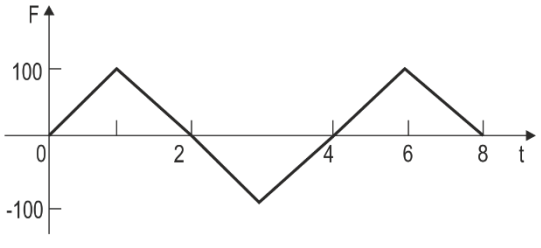
## VARIANTS

1.	 <p>Diagram of a mass-spring-damper system. A mass <math>m_1</math> is connected to a fixed point <math>P</math> via a damper <math>b_1</math> and a spring <math>k_1</math>. The displacement of the mass is <math>y(t)</math> and the displacement of the support is <math>u(t)</math>. The input <math>u(t)</math> is a sinusoidal function: <math>u(t) = \sin(\omega t)</math>, <math>\omega = 2\pi f</math>.</p>
2.	 <p>Diagram of a mass-spring-damper system. A mass <math>m_1</math> is connected to a fixed point <math>P</math> via a damper <math>b_1</math> and a spring <math>k_1</math>. The displacement of the mass is <math>y(t)</math> and the displacement of the support is <math>u(t)</math>. The input <math>u(t)</math> is a piecewise linear function defined by the following points: <math>(0,0)</math>, <math>(1,1)</math>, <math>(4,1)</math>, <math>(5,0)</math>, <math>(6,-1)</math>, <math>(9,-1)</math>, <math>(10,0)</math>.</p>
3.	 <p>Diagram of a mass-spring-damper system. A mass <math>m_1</math> is connected to a fixed point <math>P</math> via a damper <math>b_1</math> and a spring <math>k_1</math>. The displacement of the mass is <math>y(t)</math> and the displacement of the support is <math>u(t)</math>. The input <math>u(t)</math> is a piecewise linear function defined by the following points: <math>(0,0)</math>, <math>(1,1)</math>, <math>(2,0)</math>, <math>(3,-1)</math>, <math>(4,0)</math>, <math>(6,0)</math>, <math>(8,0)</math>.</p>
4.	 <p>Diagram of a mass-spring-damper system. A mass <math>m_1</math> is connected to a fixed point <math>P</math> via a damper <math>b_1</math> and a spring <math>k_1</math>. The displacement of the mass is <math>y(t)</math> and the displacement of the support is <math>u(t)</math>. The input <math>u(t)</math> is a piecewise linear function defined by the following points: <math>(0,0)</math>, <math>(1,1)</math>, <math>(1,1)</math>, <math>(2,1)</math>, <math>(6,1)</math>.</p>

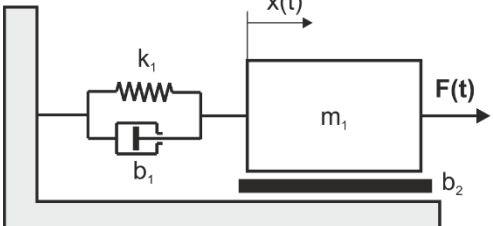
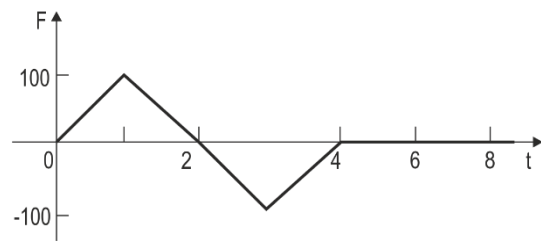
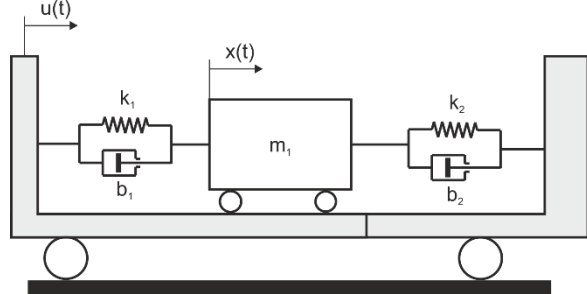
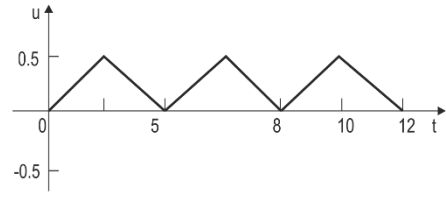
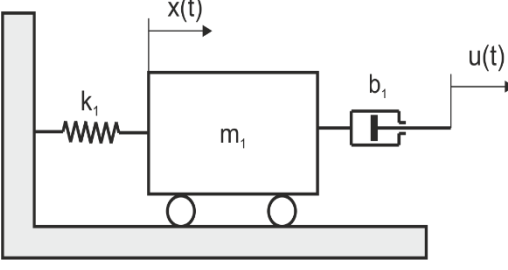
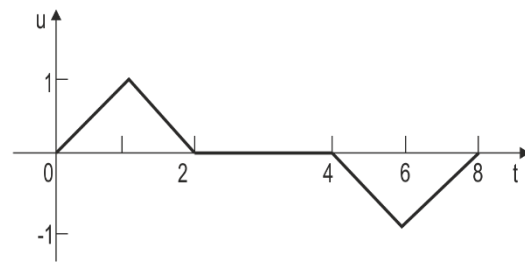
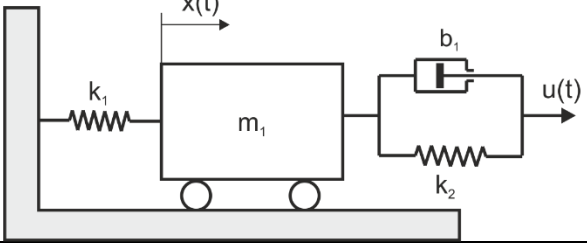
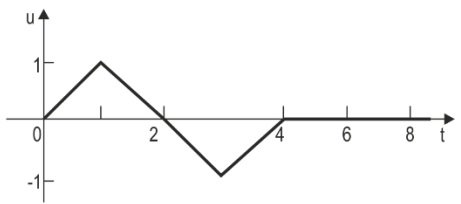
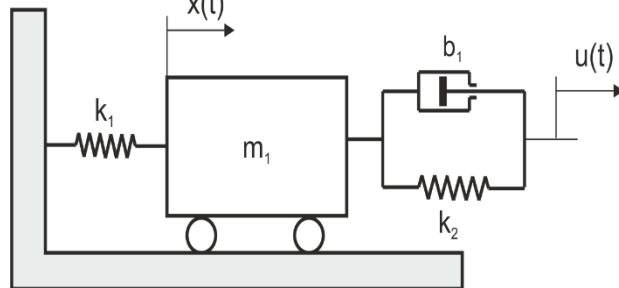
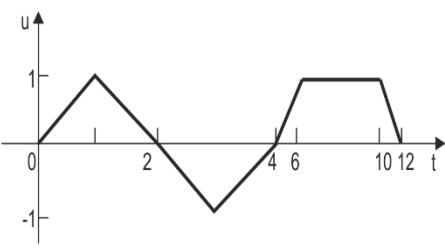
## Assignment 2

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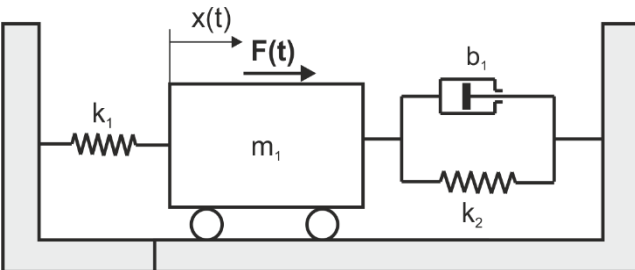
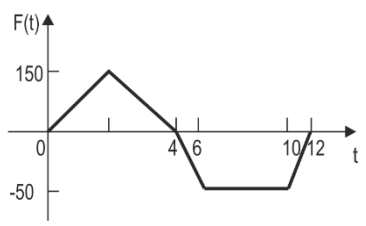
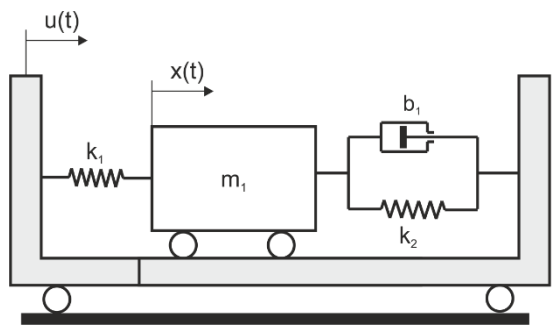
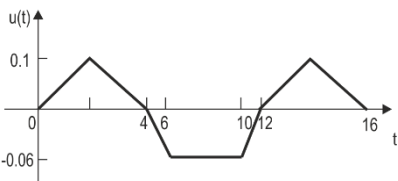
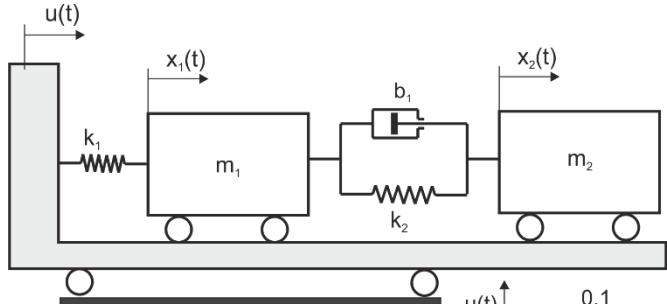
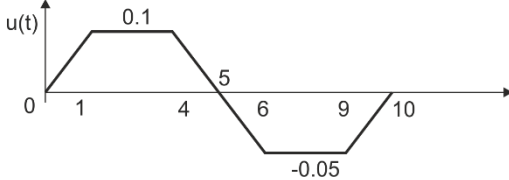
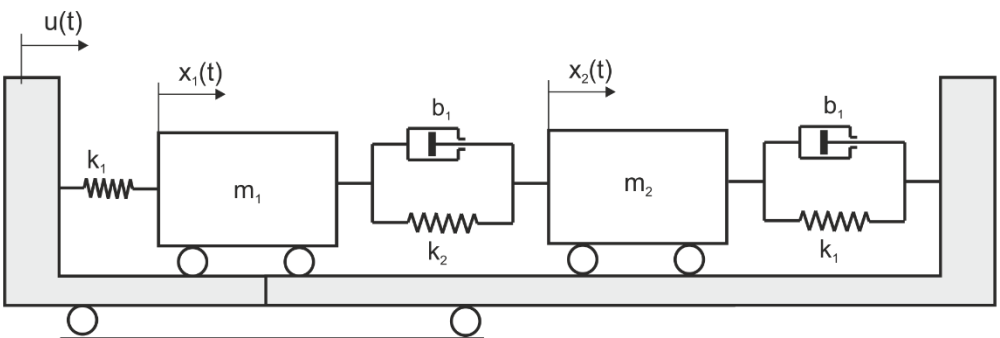
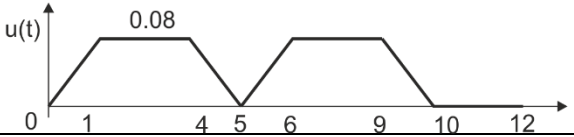
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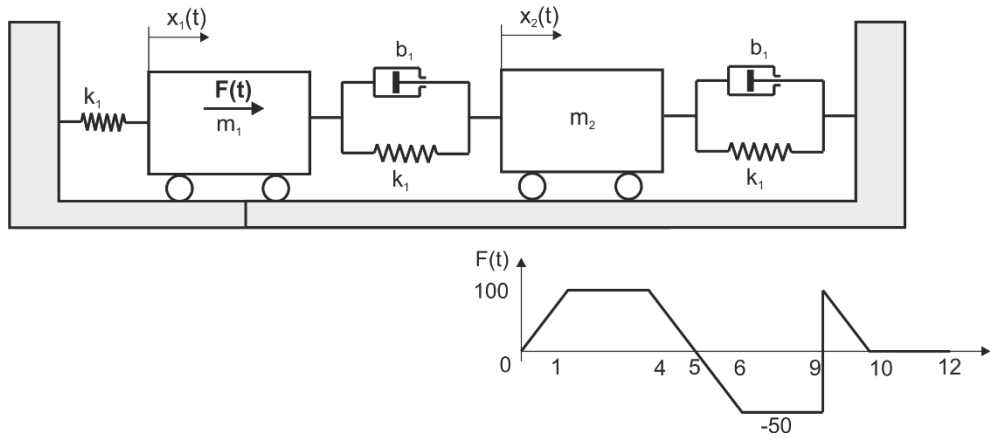
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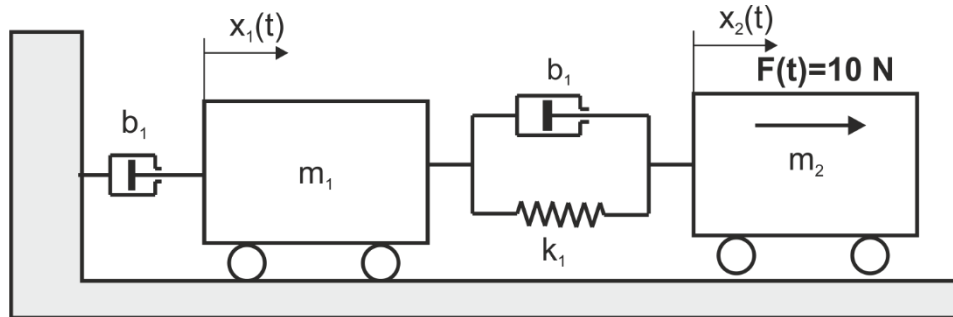


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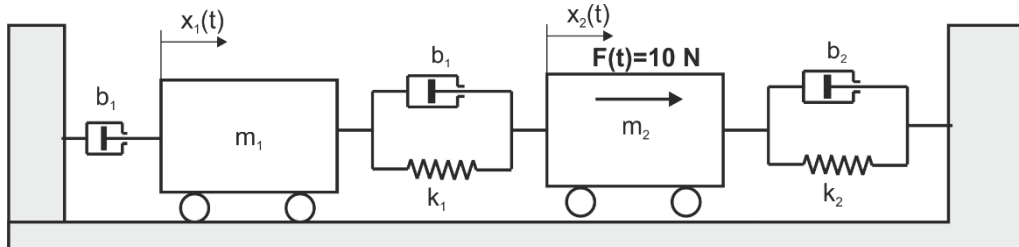
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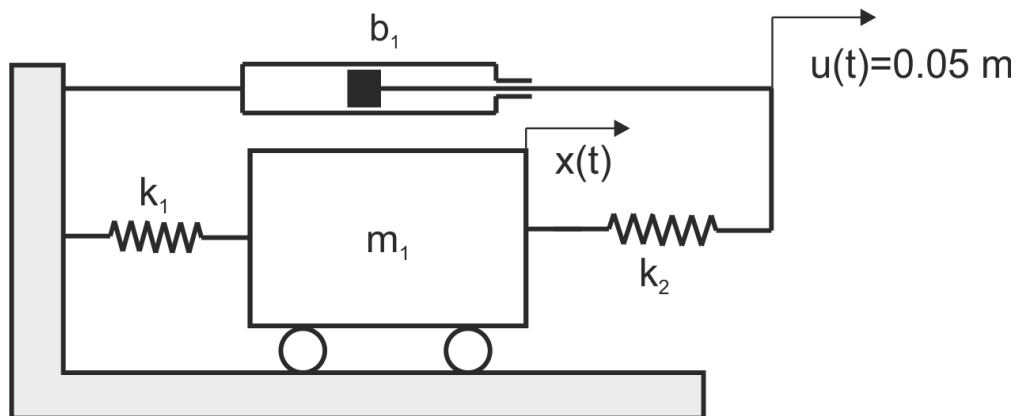
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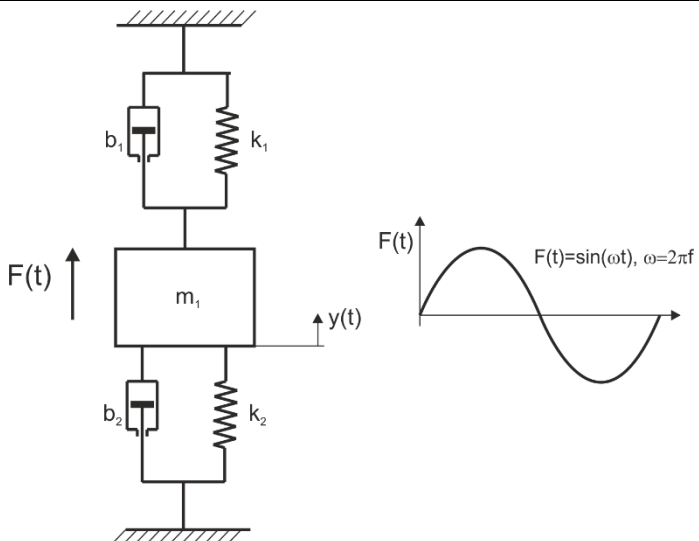
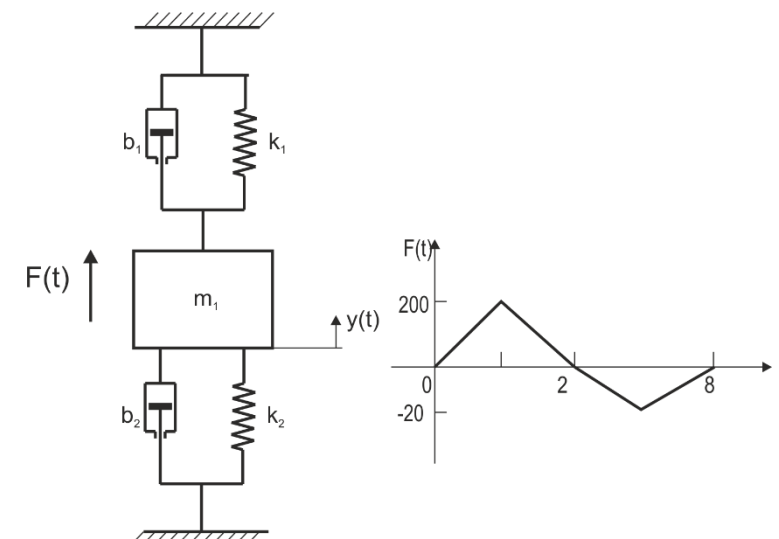
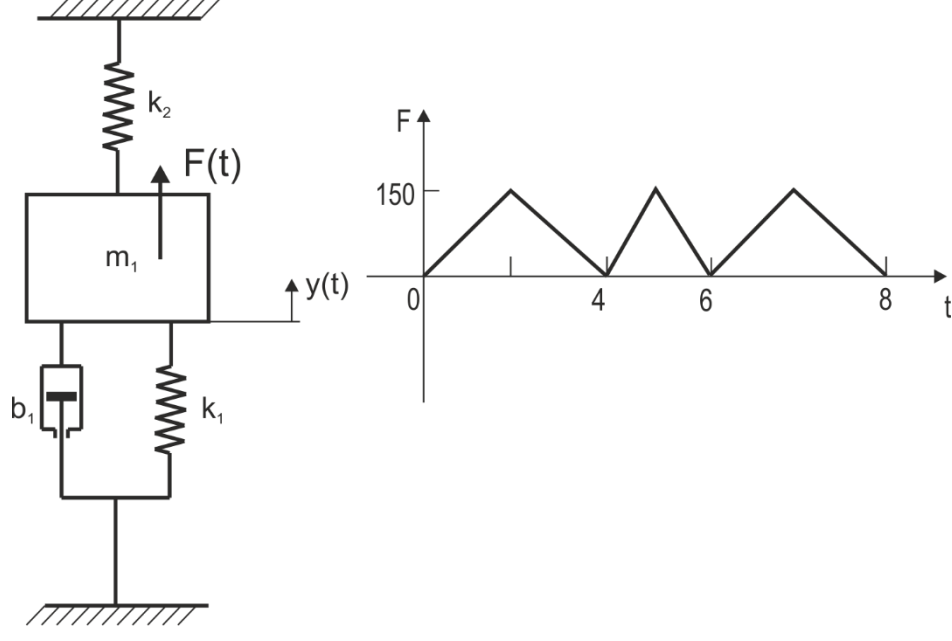
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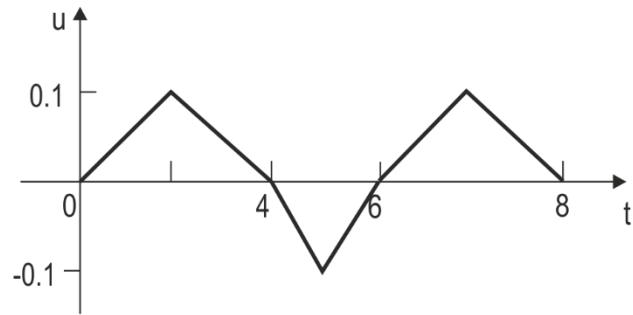
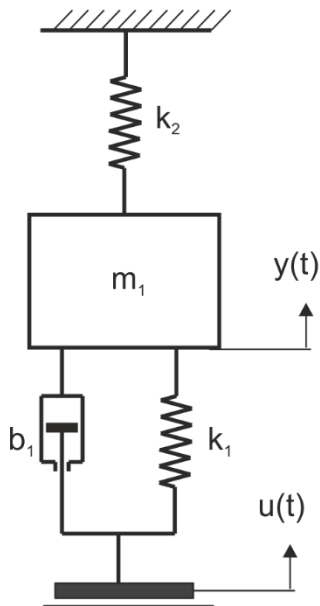
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27.	<div style="display: flex; justify-content: space-around; align-items: center; margin-top: 10px;"> <div style="text-align: center;"> </div> </div>
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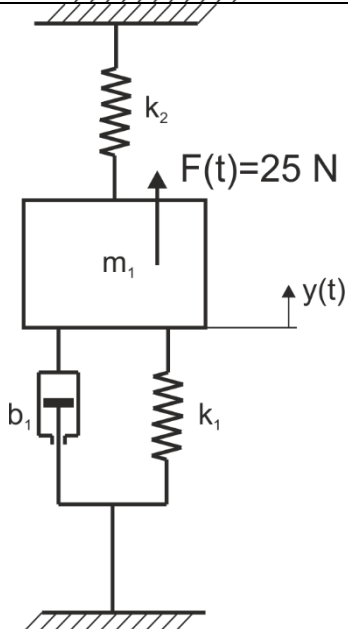
30.	 <p>Diagram of a mass-spring-damper system. A mass <math>m_1</math> is suspended from a fixed ceiling. The mass is connected to the ceiling by a parallel combination of a damper <math>b_1</math> and a spring <math>k_1</math>. The mass is also connected to a fixed ground by a parallel combination of a damper <math>b_2</math> and a spring <math>k_2</math>. An upward force <math>F(t)</math> is applied to the mass. The displacement of the mass is <math>y(t)</math>. To the right, a graph shows a sinusoidal force <math>F(t) = \sin(\omega t)</math>, with <math>\omega = 2\pi f</math>.</p>
31.	 <p>Diagram of a mass-spring-damper system, identical in structure to problem 30. The mass <math>m_1</math> is suspended from a fixed ceiling by a parallel combination of a damper <math>b_1</math> and a spring <math>k_1</math>, and connected to a fixed ground by a parallel combination of a damper <math>b_2</math> and a spring <math>k_2</math>. An upward force <math>F(t)</math> is applied to the mass. The displacement is <math>y(t)</math>. To the right, a graph shows a triangular force <math>F(t)</math> over time <math>t</math>. The force starts at 0 at <math>t=0</math>, increases linearly to a peak of 200 at <math>t=1</math>, decreases linearly to -20 at <math>t=2</math>, increases linearly to 0 at <math>t=4</math>, decreases linearly to a trough of -20 at <math>t=6</math>, and increases linearly back to 0 at <math>t=8</math>.</p>
32.	 <p>Diagram of a mass-spring-damper system. A mass <math>m_1</math> is connected to a fixed ceiling by a spring <math>k_2</math>. The mass is also connected to a fixed ground by a parallel combination of a damper <math>b_1</math> and a spring <math>k_1</math>. An upward force <math>F(t)</math> is applied to the mass. The displacement is <math>y(t)</math>. To the right, a graph shows a sawtooth force <math>F(t)</math> over time <math>t</math>. The force starts at 0 at <math>t=0</math>, increases linearly to a peak of 150 at <math>t=1</math>, decreases linearly to 0 at <math>t=2</math>, increases linearly to a peak of 150 at <math>t=3</math>, decreases linearly to 0 at <math>t=4</math>, increases linearly to a peak of 150 at <math>t=5</math>, decreases linearly to 0 at <math>t=6</math>, increases linearly to a peak of 150 at <math>t=7</math>, and decreases linearly to 0 at <math>t=8</math>.</p>

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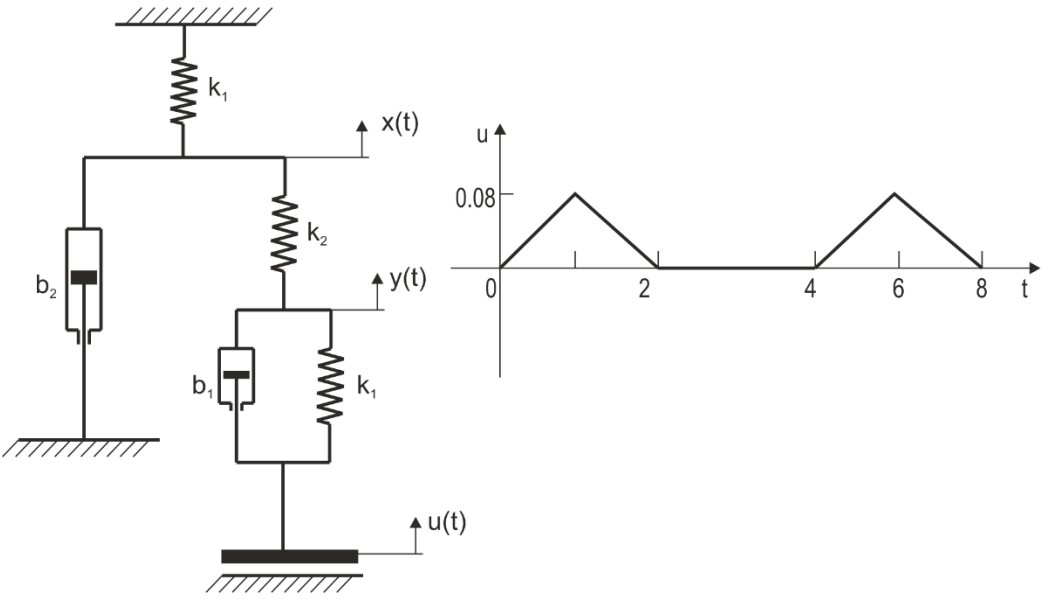
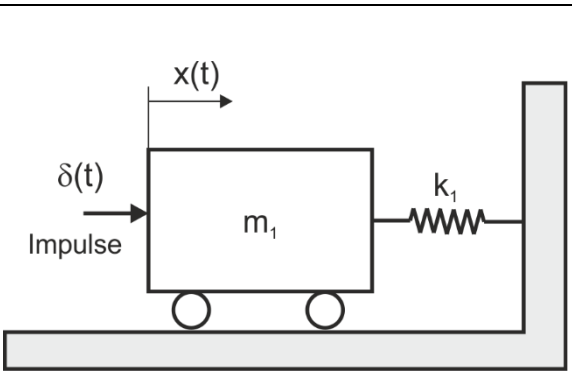
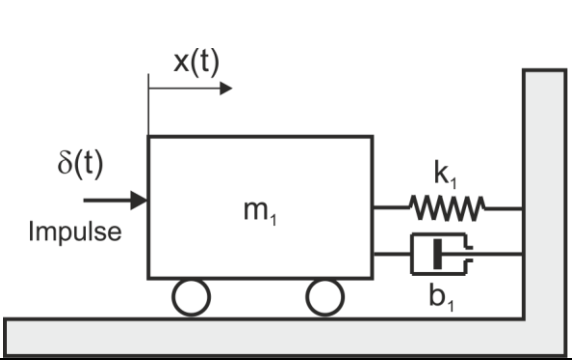
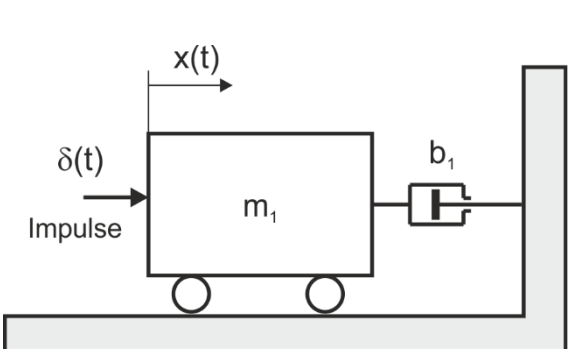
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38.	 <p>The diagram shows a two-degree-of-freedom mechanical system. A top mass is connected to a fixed ceiling by a spring <math>k_1</math>. Its displacement is <math>x(t)</math>. A damper <math>b_2</math> connects this top mass to a fixed ground. A second mass is connected to the top mass by a spring <math>k_2</math>. Its displacement is <math>y(t)</math>. This second mass is also connected to a fixed ground by a parallel combination of a damper <math>b_1</math> and a spring <math>k_1</math>. The displacement of the bottom mass is <math>u(t)</math>. To the right, a graph shows the input <math>u(t)</math> as a function of time <math>t</math>. The input is zero until <math>t=0</math>, then increases linearly to a peak of 0.08 at <math>t=1</math>, decreases linearly to zero at <math>t=2</math>, remains at zero until <math>t=4</math>, increases linearly to a peak of 0.08 at <math>t=5</math>, and decreases linearly to zero at <math>t=8</math>.</p>
39.	 <p>The diagram shows a mass <math>m_1</math> on wheels on a horizontal surface. An impulse <math>\delta(t)</math> is applied to the left side of the mass. The displacement of the mass is <math>x(t)</math>. A spring <math>k_1</math> is attached to the right side of the mass and fixed to a vertical wall on the right.</p>
40.	 <p>The diagram is identical to problem 39, but includes a damper <math>b_1</math> in parallel with the spring <math>k_1</math> on the right side of the mass.</p>
41.	 <p>The diagram is identical to problem 40, but the spring <math>k_1</math> is removed, leaving only the damper <math>b_1</math> on the right side of the mass.</p>