Name _____

Student ID# _____

Quiz #1 **Engineering Analysis - 3** **Spring 2024**

Maximum time allowed is 50 minutes

Use only a pen and calculator.

No cellphones, computers, notes, books, or cheat sheets.

In this quiz, all the masses, springs, and dampers are ideal and linear.

All the referenced figures are on the last page, which you may tear off for your easy reference. Do not turn in the last page as it will not be graded.

<u>Your Affirmation:</u>

On my honor I have neither given nor received help on this quiz and I will not

discuss content of the quiz with other students until 3 pm. (1pt) _____

Sign your name above

30 1. Determine if the following statements are True or False and circle **T or F**

A) **T / F :** Two springs with identical k value of 10 are parallel in the first arrangement. The resulting effective spring constant is 20.

B) **T / F :** Now in a second arrangement, if one of the above springs is removed and if the remaining spring is connected in series with a new spring. It is possible for equivalent spring constants in both configurations to be the same since the k value of the new spring is not provided.

C) **T / F :** In a viable one bungee jump, the velocity of the jumper at the bottom of the first occurrence and at the bottom of any subsequent occurrences is always zero.

D) **T / F :** In a viable one bungee jump, the acceleration of the jumper at the bottom of the first occurrence and at the bottom of any subsequent occurrences is always zero.

E) **T / F :** In Figure 1, the number of independent state variables is six.

F) **T / F :** In Figure 1, V2 + V3 – V4 = 0

G) **T / F :** In Figure 1, $X'_6 = -(k_6/b_5)X_6$

H) **T / F :** In Figure 2, FBE yields: $m_3a_3+k_1X_1+ b_2V_2=0$

I) **T / F :** In Figure 2, when a_3 is zero, $V_2=0$

J) **T / F :** In Figure 2, when V_2 is zero, $X_1=0$

49 2. Refer to Figure 3 at the bottom. Answer the following questions:

Name the independent state variables: (3 points)
Force balance equation(s): (5 points)
Geometric continuity equation(s): (5 points)
Constitutive laws(s): (5 points)
Equation(s) of motion using symbols: (25 points)

Write equation(s) of motion simplified by substituting the values of all parameters: (6 points)

20 3. Assuming $\delta t = 0.5$ seconds and using Euler's Forward method, determine the values of X_1, X_2, and V_3 at t=2.0 for the following set of Equations of Motion:

$X_1' = 2X_1 + 2X_2$
$X_2' = 2V_3 + 2$
$V_3' = X_1 + X_2 + V_3 + 1$

t	X_1	X_2	V_3	X_1'	X_2'	V_3'	
1	**1**	**2**	**3**				
1.5							
2.0							

Show your calculations and not just the final answers!

Figure 1

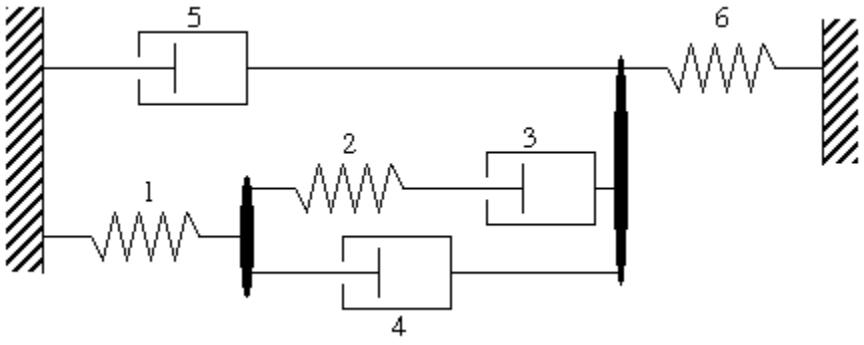


Figure 2

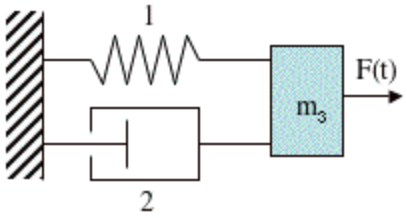
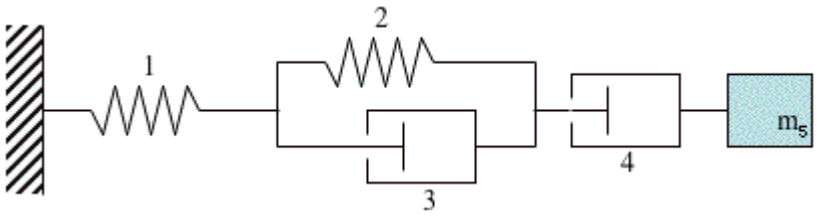


Figure 3



k_1=2; k_2=4; b_3=2; b_4=4; and m_5=10

Name KEY -T

Student ID# _____

Quiz #1 **Engineering Analysis - 3** **Spring 2024**

Maximum time allowed is 50 minutes

Use only a pen and calculator.

No cellphones, computers, notes, books, or cheat sheets.

In this quiz, all the masses, springs, and dampers are ideal and linear.

All the referenced figures are on the last page, which you may tear off for your easy reference. Do not turn in the last page as it will not be graded.

Your Affirmation:

On my honor I have neither given nor received help on this quiz and I will not

discuss content of the quiz with other students until 3 pm. (1pt) _____

Sign your name above

30 1. Determine if the following statements are True or False and circle **T or F**

A) **T / F :** Two springs with identical k value of 10 are parallel in the first arrangement. The resulting effective spring constant is 20.

B) **T / F :** Now in a second arrangement, if one of the above springs is removed and if the remaining spring is connected in series with a new spring. It is possible for equivalent spring constants in both configurations to be the same since the k value of the new spring is not provided.

C) **T / F :** In a viable one bungee jump, the velocity of the jumper at the bottom of the first occurrence and at the bottom of any subsequent occurrences is always zero.

D) **T / F :** In a viable one bungee jump, the acceleration of the jumper at the bottom of the first occurrence and at the bottom of any subsequent occurrences is always zero.

E) **T / F :** In Figure 1, the number of independent state variables is six.

F) **T / F :** In Figure 1, $V2 + V3 - V4 = 0$

G) **T / F :** In Figure 1, $X'_6 = -(k_6/b_5)X_6$

H) **T / F :** In Figure 2, FBE yields: $m_3a_3+k_1X_1+ b_2V_2=0$

I) **T / F :** In Figure 2, when a_3 is zero, $V_2=0$

J) **T / F :** In Figure 2, when V_2 is zero, $X_1=0$

(A) $K_{eq} = 10+10 = 20$ [Parallel]

(B) Is it possible to have, [series]

$$\frac{10 \cdot K_{new}}{10 + K_{new}} = 20$$

$\therefore K_{new} = \ominus 20$! Not possible

(C) Vel is indeed zero @ bottom

(D) Accelertion is not zero because at the next moment jumper will move up!

(E) Three variables

(F) continuity equation yields $V_2+V_3=V_4$

(G) Force is not a through variable now!

(H) F(t) is missing all together!

(I) constant velocity is still possible

(J) $V_2 = 0$ but $V_2 = V_1$ $\therefore X_1' = 0$ $\therefore X_1 =$ Constant

49 2. Refer to Figure 3 at the bottom. Answer the following questions:

Name the independent state variables: (3 points) x_1 x_2 v_5

Force balance equation(s): (5 points)

$$F_1 = F_2 + F_3 = F_4$$

$$m_5 v_5' = -F_4$$

Geometric continuity equation(s): (5 points)

$$v_1 + v_2 + v_4 = v_5 \qquad v_2 = v_3$$

Constitutive laws(s): (5 points)

$$F_1 = k_1 x_1 \qquad F_2 = k_2 x_2$$

$$F_3 = b_3 v_3 \qquad F_4 = b_4 v_4 \qquad \leq F = m_5 v_5'$$

Equation(s) of motion using symbols: (25 points)

$$m_5 v_5' = -F_4 = -F_1 = -k_1 x_1$$

$$\therefore v_5' = -(k_1/m_5) x_1$$

$$v_2 = v_3$$

$$\therefore x_2' = F_3/b_3 = \frac{F_1 - F_2}{b_3}$$

$$\therefore x_2' = \frac{k_1}{b_3} x_1 - \frac{k_2}{b_3} x_2$$

$$v_1 + v_2 + v_4 = v_5$$

$$\therefore x_1' = v_5 - v_2 - v_4$$

$$= v_5 - \frac{k_1}{b_3} x_1 + \frac{k_2}{b_3} x_2 - \frac{F_4}{b_4}$$

$$x_1' = v_5 - \frac{k_1}{b_3} x_1 + \frac{k_2}{b_3} x_2 - \frac{k_1 x_1}{b_4}$$

$$\therefore V_5' = -\frac{K_1}{m_5} x_1 = -\frac{2}{10} x_1$$

$$\therefore x_2' = \frac{K_1}{b_3} x_1 - \frac{K_2}{b_3} x_2 = \frac{2}{2} x_1 - \frac{4}{2} x_2$$

$$\therefore x_1' = V_5 - x_1 + 2x_2 - \frac{K_1}{b_4} x_1$$

$$= V_5 - x_1 + 2x_2 - \frac{2}{4} x_1$$

Write equation(s) of motion simplified by substituting the values of all parameters: (6 points)

$$V_5' = -0.2 x_1$$

$$x_2' = x_1 - 2x_2$$

$$x_1' = V_5 - 1.5 x_1 + 2x_2$$

20 3. Assuming $\delta t = 0.5$ seconds and using Euler's Forward method, determine the values of X_1; X_2; and V_3 at t=2.0 for the following set of Equations of Motion:

$X_1' = 2X_1 + 2X_2$
$X_2' = 2V_3 + 2$
$V_3' = X_1 + X_2 + V_3 + 1$

t	X_1	X_2	V_3	X_1'	X_2'	V_3'	
1	1	2	3	6	8	7	
1.5	4	6	6.5	20	15	17.5	
2.0	14	13.5	15.25	55	32.5	43.75	

Show your calculations and not just the final answers!

@ 1.5

$\therefore X_1 = 1 + 0.5 * 6 = 4$
$X_2 = 2 + 0.5 * 8 = 6$
$V_3 = 3 + 0.5 * 7 = 6.5$

@ t = 2.0

$\therefore X_1 = 4 + 0.5 * 20 = 14$
$X_2 = 6 + 0.5 * 15 = 13.5$
$V_3 = 6.5 + 0.5 * 17.5 = 15.25$

Figure 1

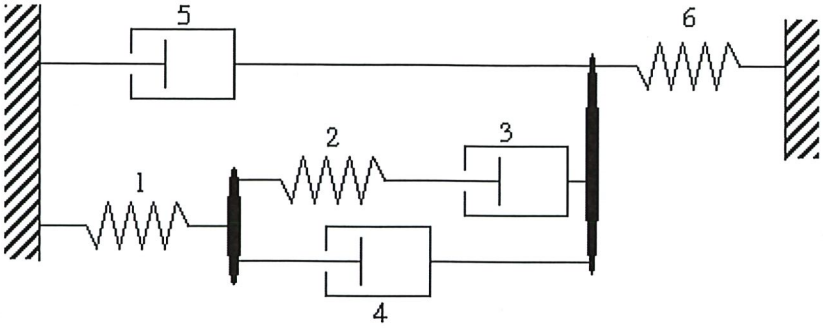


Figure 2

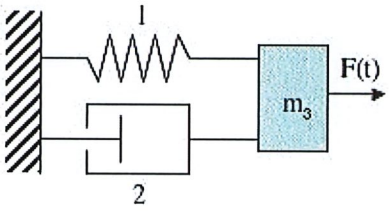
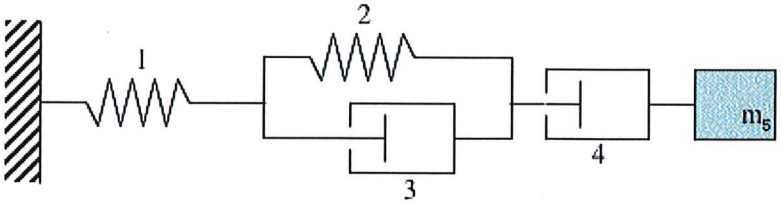


Figure 3



$k_1=2$; $k_2=4$; $b_3=2$; $b_4=4$; and $m_5=10$