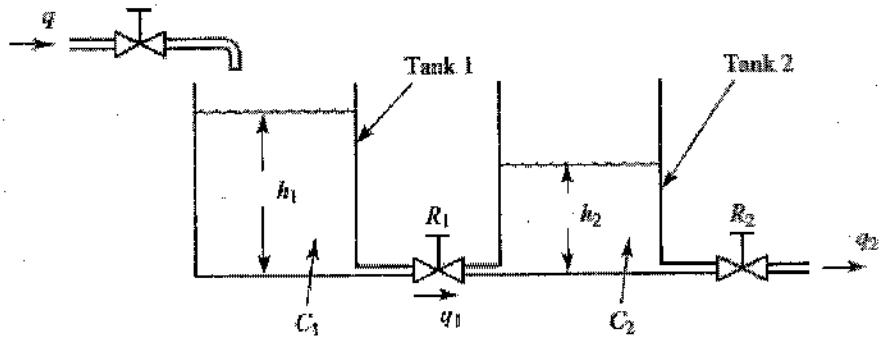
**KafrelSheikh University**
**Faculty of Engineering**
**Electrical Engineering Department**
**Final Exam, 2020 - 2021**
**Subject: Modeling and Simulation.**

**Year: 3th Computer Engineering & systems**
**Academic Number : ECS3214**
**Date: 21 / 6 / 2021**
**Time: 3 Hours.**
**Full Mark: 100, 2 pages**

***This course must be able to satisfy the competencies for BASIC Electrical engineering discipline (Level B): B2 and the Computer Engineering and Systems competencies (Level C): C3 & C5.***

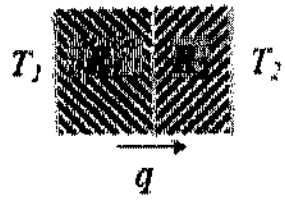
## Question 1: [20 degree]

Consider the system shown below. In this system, the two tanks interact. Construct a block diagram to describe this system, simplify it then get the transfer function $\frac{Q_2(s)}{Q(s)}$




## Question 2: [15 degree]

Two bodies at temperature $T_1$ and $T_2$ are separated by two elements with different thermal resistance $R_1$ and $R_2$. Heat flows through the two elements at a rate of $q$. **Find** the equivalent thermal resistance $R_{eq}$ and **Solve** for the interface temperature between the two elements.




## Question 3: [25 degree]

(a) Show how the PID controller adds a pole at origin and double zeros at $s = \frac{-4}{P_{cr}}$ **[5 degree]**

(b) Consider the system $G(s) = \frac{1}{s^3+2s^2+4s}$ Design a **PID**-controller using Zigler-Nicholes method. It is required to find $K_{cr}$, $P_{cr}$. **[20 degree]**

## Question 4: [30 degree]

(a) Deduce the state space model of DC motor with armature controlled. **[5 degree]**
(b) Consider a train consisting of an engine and a car, as shown below. A controller is applied to the train so that it has a smooth start and stop, along with a constant-speed ride.

The mass of the engine and the car will be represented by ***M1*** and ***M2***, respectively. The two are held together by a spring, which has the stiffness coefficient of ***k***. ***F*** represents the force applied by the engine, and $\mu$, represents the coefficient of rolling friction.

(a) Draw the free body diagram. **[5 degree]**

(b) Find the state variables and output equations. **[5 degree]**

(c) Find the transfer function **[5 degree]**

(d) Write the state space equations of the system. **[5 degree]**

## Question 5: Choose the correct answer: [10 degree]

1- **In P-D controller, the derivative action plays a significant role in increasing _____ of response.**

a) Time b) Distance c) Speed d) Volume

2- **Which among the following are the elements of rotational motion?**

a) Mass, Spring, Friction
b) Inertia, Damper, Spring
c) Work, Energy, Power
d) Force, Pressure, Viscosity

3- **The integral control:**

a) Increases the steady state error
b) Decreases the steady state error
c) Increases the noise and stability
d) Decreases the damping coefficient

4- **For proportional control the steady state error (offset) tends to Zero when Kp is:**

a) Infinity b) Zero c) One d) 0.5

5- **PID controller is used when system requires**

a) System changes are small
b) Offset must be eliminated
c) Fast recovery time
d) All above

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**Appendix:**

| Type of controller | $k_p$ | $T_i$ | $T_d$ |
|---|---|---|---|
| P | $0.5\ K_o$ | $\infty$ | $0$ |
| PI | $0.45\ K_o$ | $0.83\ T_o$ | $0$ |
| PID | $0.6\ K_o$ | $0.5\ T_o$ | $0.125\ T_o$ |

********** **Good Luck**********

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