Q1. The SENT specimen is prepared for fracture testing and subjected to tension to obtain load varying with respect to time, and the obtained values are presented in the Table 1. The load is a function of time and is given by the equation $F = c_1 t + c_2$. According to given equation obtain $c_1$ and $c_2$ coefficients.

Table 1

<table>
<thead>
<tr>
<th>t [min]</th>
<th>F [kN]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
</tr>
</tbody>
</table>

Q2. A mechanical system is shown in Figure 1 and the $f(t)$ is given as input and $x(t)$ as output. Neglect the weight of the beam. The equation of motion of the system is given as:

$$20 \frac{d^2 x}{dt^2} - f(t) = -5000x$$

a) If $f(t) = 100e^{-t}\cos(5t + 0.4)$ is an input function, find $x(t)$.
b) Chose one of the input function (given below) which causes the resonance. Why?

(i) $f(t) = 4\cos 5t$  (ii) $f(t) = 4e^{-t}\cos 5t$  (iii) $f(t) = 10\cos(15.811t - 0.4)$  (iv) $f(t) = 10e^{-t}\cos(15.811t - 0.4)$

Q3. In a system, $r(t)$: input, $c(t)$: output and the defining differential equation of a system is:

$$12 \frac{d^3 c}{dt^3} + 5 \frac{d^2 c}{dt^2} - 6.5 \frac{d^2 r}{dt^2} + 3 \frac{dc}{dt} + 2 \frac{dr}{dt} + 4c = 5.5r$$

a) Find the transfer function of the system?
b) How can you find the eigenvalues with MATLAB?
c) If the initial conditions at $t=0$, $c=2$, $\dot{c} = 0$, $\ddot{c} = 5$, find the Laplace transform based on initial conditions.

Q4. The equation of motion of a mechanical system given in Figure 2 is:

$$m \frac{d^2 x}{dt^2} + c \frac{dx}{dt} = -f(t) - 3kx$$

a) If $f(t)$ is an impulse input with magnitude 10, write the MATLAB code to obtain Partial Fraction Expansion for the output of Laplace transform.
b) If $f(t)$ is a step input with magnitude 100 N, write the MATLAB code to obtain Partial Fraction Expansion for the output of Laplace transform.

$m=100 \text{ kg, } c=10 \text{ Ns/m, } k=10000 \text{ N/m}$

Q5) Partial fraction expansion of the Laplace transform of an output of a step input is given as:

$$Y(s) = \frac{12.6 - 4i}{s - (-5.8 + 6.3i)} + \frac{2.4}{s + 231} - \frac{2.8}{s}$$

Find $y(t)$. Is the system stable (stationary)? Write the reason.

En Küçük Kareler Yöntemi: $y=a+bx$

$$\begin{bmatrix} n & \sum x_i \sum y_i \\ \sum x_i & \sum x_i^2 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum x_i y_i \end{bmatrix}$$