FINAL PROJECT

INTERACTIVE MEDICAL ROBOTICS
ROB-GY 6423

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Question 1

For the given system wave variable can not be applied. Wave variable requires the delay to be constant. In the system due to the cos function the delay becomes variable. Therefore wave variable can not be used.
Due to the time delays T_1 & T_2 they do not ensure passivity properties hold throughout the operation. The delay can introduce phase shifts & cause the system to oscillate & become unstable.
For variable communication delay passivation by scaling can be used. To dissipate excess energy the wave variables can be scaled

$$U_s(t) = U_m[t - T_1(t)]$$
$$V_m(t) = V_s[t - T_2(t)]$$

scaling $u_s(t) = g_1 \cdot u_m[t - T_1(t)]$, $V_m(t) = g_2 \cdot V_s[t - T_2(t)]$

energy balance : $E(t) = \frac{1}{2}\int_0^t (|u_m^T(\tau)|^2 - |V_m^T(\tau)|^2 - |u_s^T(\tau)|^2 + |V_s^T(\tau)|^2 d\tau$

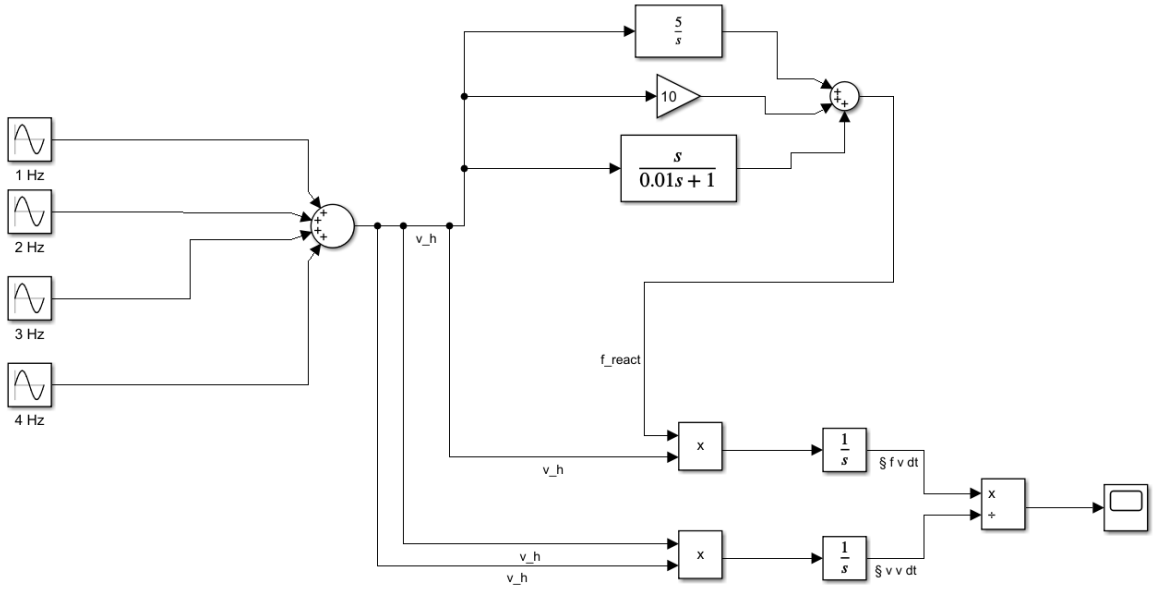
if $E(t) \geq 0$, passivity is regained

Passivity by scaling ensures passivity of the system but does not ensure stability.
In the force - position domain passivity by scaling is stable but the given system is in the force - velocity domain

No applying wave variable or passivation by scaling the waves, would not guarantee stability of the system

M - TDPC is better than TDPC as it explicitly considers time varying communication delays in control design making it more effective to achieve stability

Question 2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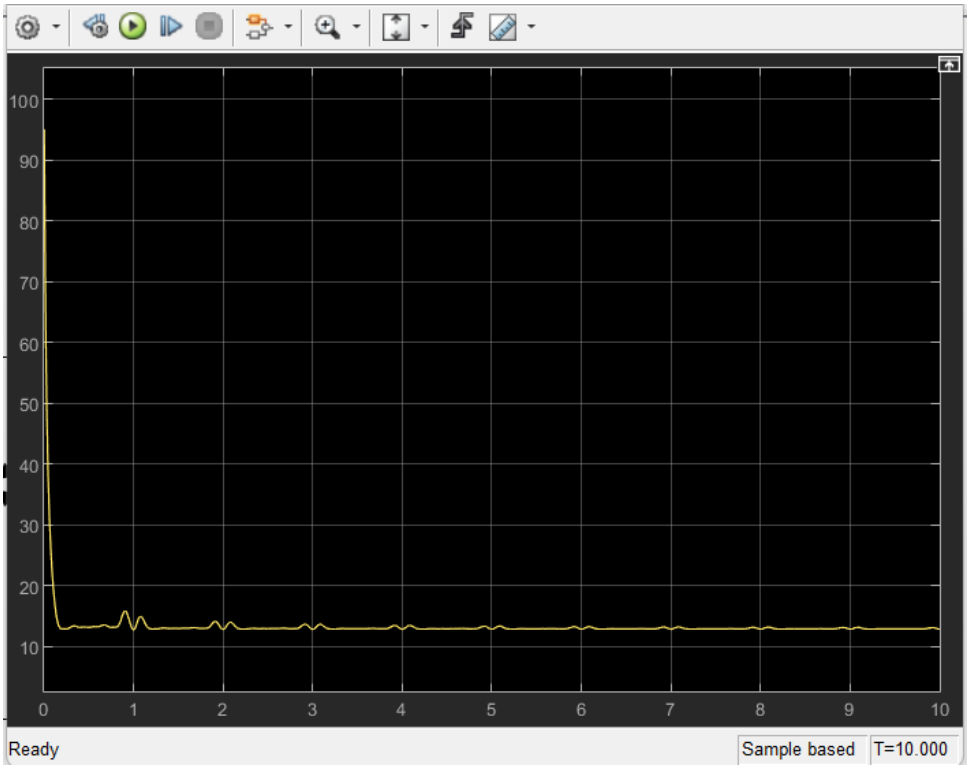
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