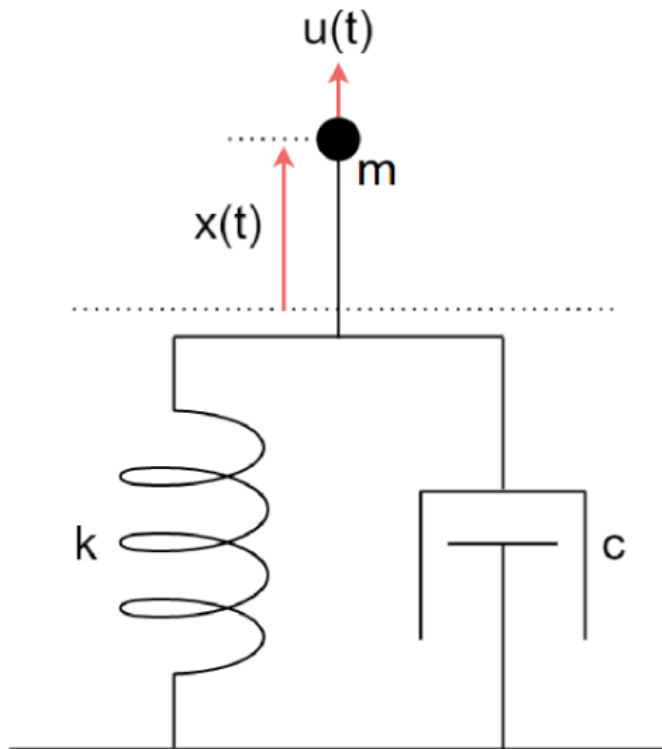


5.1 Mass-spring-damper system



Figuren over viser et dempet masse-fjær-system, der m er objektets masse, k er fjærkonstanten, c er dempings koeffisienten, D er eksterne krefter klassifisert som støy, $x(t)$ er massens forflytning ved tid t , and $u(t)$ er kontrollkraften ved tid t .

Systemet kan beskrives ved følgende andre-ordens differensiallikning:

$$m\ddot{x}(t) + c\dot{x}(t) + kx(t) + D = u(t)$$

Oppgaver:

Transformer likningen over fra tidsdomenet til Laplacedomenet. Tegn et lukket-sløyfe blokkdiagram for systemet.

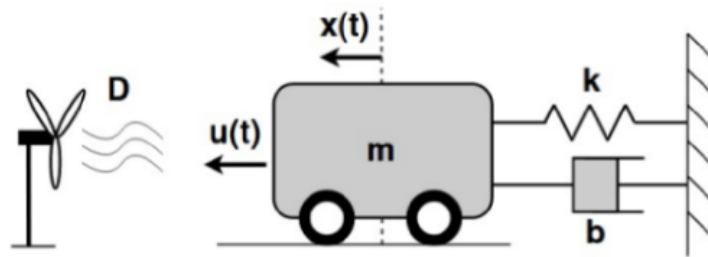
Maks poeng: 5

5.2 PI-controller

Legg til en PI-kontroller til systemet, med en ønsket masseforflytning $X_d(s)$. Inkluder PI-kontrolleren i systemets likning (likningen fra oppgave 5.1). Finn transferfunksjonen ved å løse den nye likningen med hensyn på $X(s)$.

Maks poeng: 5

Task 7: Mass-spring-damper Control (16%)



The above image demonstrates a mass-spring-damper system, where m is the object mass, k is the spring constant, b is the damping coefficient, D is the system disturbance, $x(t)$ is the mass displacement at time t , and $u(t)$ is the input force. The system can be described with the following differential equation:

$$m\ddot{x}(t) + b\dot{x}(t) + kx(t) + D(t) = u(t)$$

a) 5% Transform the above equation from time domain to Laplace domain. Draw the closed-loop block diagram of the system.

Task 4 [INF3480/INF4380] (20%):

We have the system $J\ddot{\theta}(t) + B\dot{\theta}(t) + K\theta(t) = \tau$. When we use the Laplace transform on the system, we get $J s^2 \theta(s) + B s \theta(s) + K \theta(s) = \tau$.

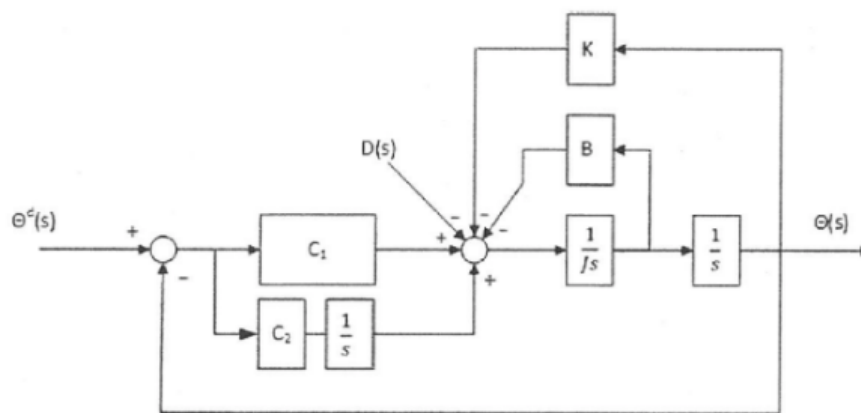


Figure 4: Control system

a) (2.5%) Figure 4 shows up a set-point tracking control system in the Laplace domain. What is the name of the controller used here? What properties does it provide to the system?

b) (2.5%) The system with the controller in Figure 4 have oscillations. How can we remove the oscillations while keeping the other system properties? What is the name of the new controller?

e) (5%) Transform the following equation the Laplace domain:

$$m\ddot{x} + kx = u$$

Find the transfer function of this system, assuming that u is the input and x is the output. Draw a block diagram of the system.

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$$J\ddot{\theta} + b\dot{\theta} + k\theta = \tau$$

b) (7.5 %) Transformer den dynamiske likningen over til Laplace-domenet. Tegn opp blokkdiagrammet til det tilbakeløpde systemet (closed loop system) to ganger:

- først ved bruk av en P-regulator
- deretter ved bruk av en PI-regulator