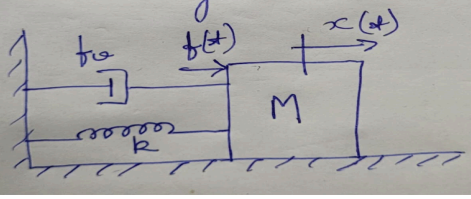
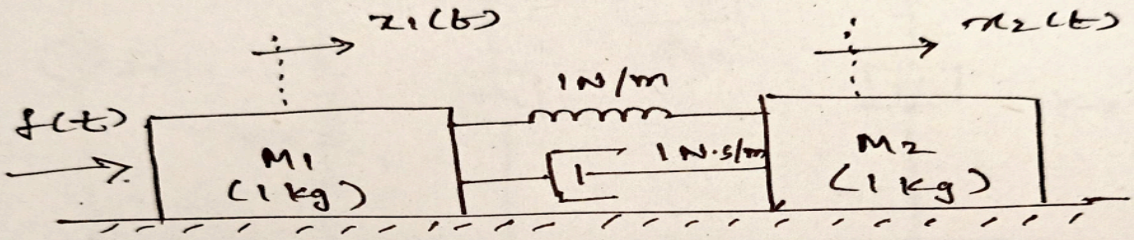
Tutorial sheet 2, Control Systems Course: EE302-S1-BTech section, 28th Jan 2025

01) Consider the following spring-mass-damper system and find T.F. $X(s)/F(s)$. Assume the spring to be unstretched and uncompressed at $x=0$ (the system is relaxed initially). Any mechanical system of such kind can be represented with an analogous electrical circuit. Draw the equivalent electrical network using Force-voltage and current-velocity analogy for the given mechanical system.



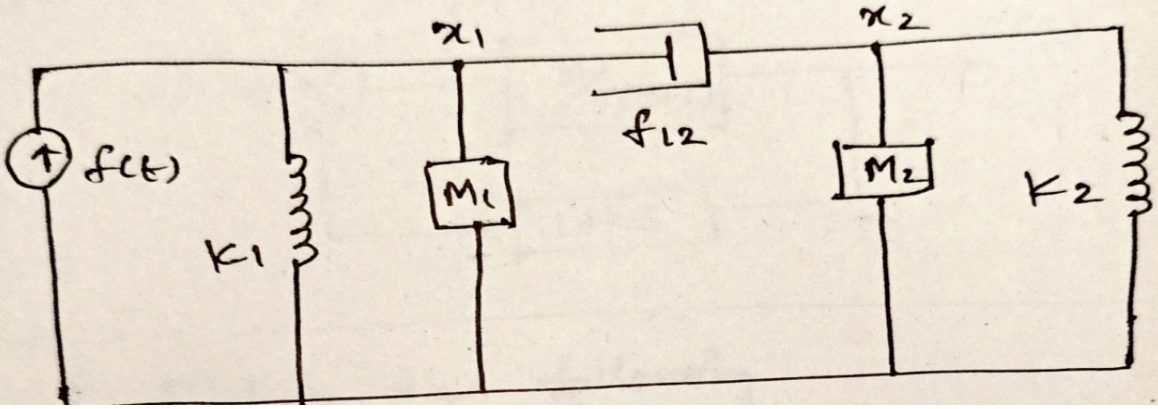
02) 1) Find transfer function $G(s) = \frac{X_2(s)}{F(s)}$ for translational mechanical system (as) (mechanical network shown below)



03) Q3) Convert the given Mechanical circuit Diagram into corresponding electrical analogous system driven by

a) voltage source

b) current source.



04)

Q.6) Match the following

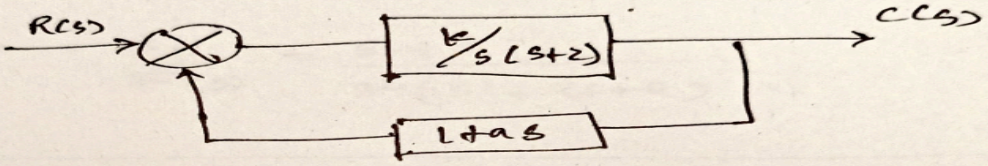
(i) s^2+5s+6 — (A) Undamped

(ii) s^2+100 — (B) Underdamped

(iii) s^2+2s+2 — (C) Over damped

05)

Q.5) For the system shown below with a damping ratio ξ of 0.7 and undamped natural frequency ω_n of 4 rad/sec the values of K and a are _____ and _____



06)

Q) Obtain a transfer function (which is second order and without any zeros) such that:

DC gain = 10

% OS = 8%

Settling time (2%) = 10 sec

Check that if it is possible to have peak time as 2 seconds too.

07)

Consider the given T.F. $G(s) = \frac{2P}{(s+2)(s+P)}$. Find the partial fraction expansion for the step response of same T.F. Find out the coeff. of the partial fractions (also called as residues) in terms of the pole P. Then analyse the contribution of the coefficients corresponding to the pole as P varies from some value a, to ∞.

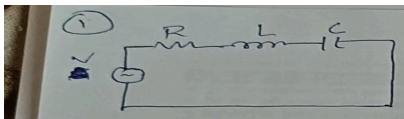
08)

Q7) 2nd order control system is defined by the D-E as $4\frac{d^2c(t)}{dt^2} + 8\frac{dc(t)}{dt} + 2c(t) = 16r(t)$

The damping ratio and natural frequency for this system are ____ and ____ respectively.

$r(t)$ → input
$c(t)$ → output

09)



$V = 10\sin\omega t$, $R = 6\Omega$, $L = 3H$, $C = 3F$

(i) Derive the transfer fn of the circuit when output is measured across capacitor

(ii) Show that damping ratio (ξ) is Proportional to R

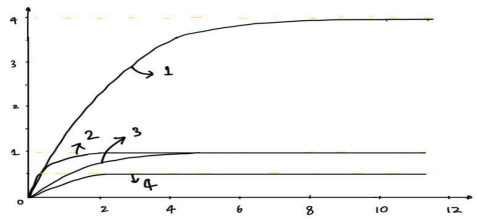
(iii) Calculate the natural frequency and ξ

(iv) What is the Range of R for the system to be underdamped

Match the step responses with their corresponding transfer functions.

10)

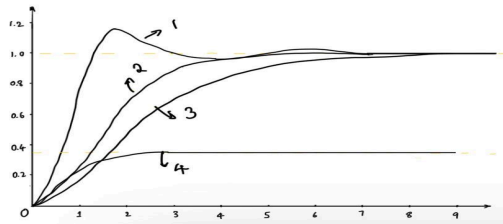
[A]



(a) $\frac{1}{s+1}$ (b) $\frac{2}{s+0.5}$ (c) $\frac{4}{s+0.1}$

(d) $\frac{3}{s+3}$ (e) $\frac{1}{s+2}$ (f) $\frac{6}{s+9}$

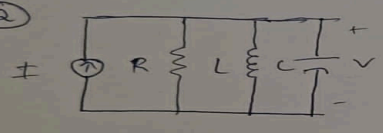
[B]



(a) $\frac{1}{s^2+2s+1}$ (b) $\frac{2}{s^2+2\sqrt{2}s+2}$ (c) $\frac{1}{s^2+6s+10}$

(d) $\frac{3}{s^2+6s+9}$ (e) $\frac{4}{s^2+2s+4}$ (f) $\frac{8}{s^2+4s+2}$

11)



$I = 3\sin\omega t$, $R = 18\Omega$, $L = 9H$, $C = 1F$

(i) find $\frac{V(s)}{I(s)}$, $V(s)$ is voltage across capacitor

(ii) Show that damping ratio is inversely Proportional to R

(iii) calculate natural freq and ξ

(iv) What is the Range of R for the system to be underdamped