EE302 : Assignment 1

1) Find inverse Laplace transforms of the following transfer functions:

a) $G(s) = \dfrac{5(s+2)}{s(s^2+6s+9)}$ b) $G(s) = \dfrac{s}{(s^2+1)^2}$

c) $G(s) = \dfrac{s^2+s+2}{s+1}$

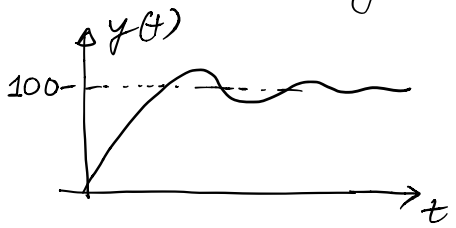
Show the steps required for hand-computation and also write the code required (in the language of your choice) to verify your computation on a computer.

2) Find the impulse response of the following differential equation:

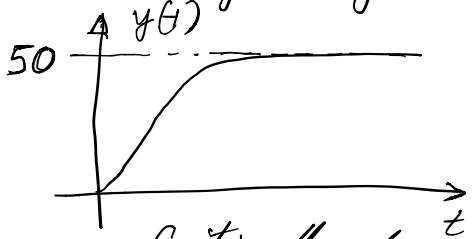
$$\frac{d^2y}{dt^2} + 6\frac{dy}{dt} + 2y(t) = 2\frac{dr(t)}{dt} + r(t)$$

(Assume zero initial conditions)

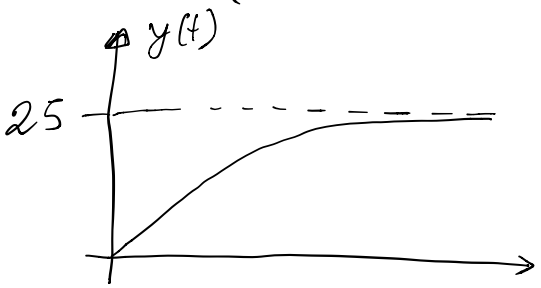
3) Consider the following unit step responses:



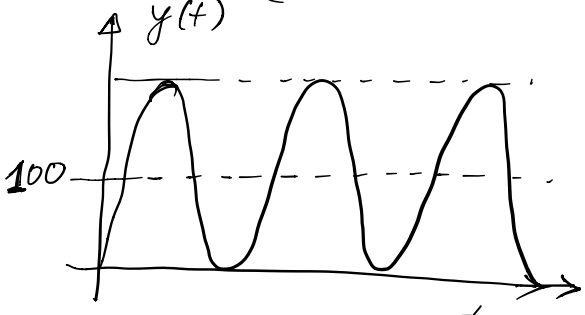
Underdamped
(i)



Critically damped
(ii)



Over damped
(iii)

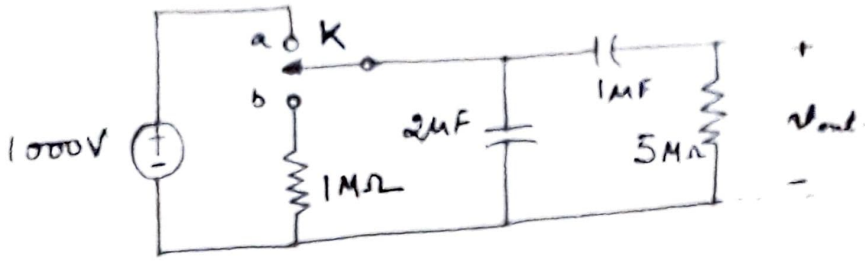


Undamped
(iv)

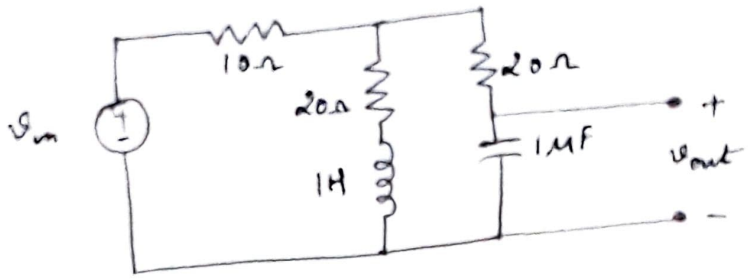
a) Give one example each of transfer functions which will have unit step responses as shown in figures (i) - (iv) above. (Please note the magnitudes of the outputs marked on the y-axes)

b) For each of your examples calculate the pole locations, damping ratios and natural frequencies.

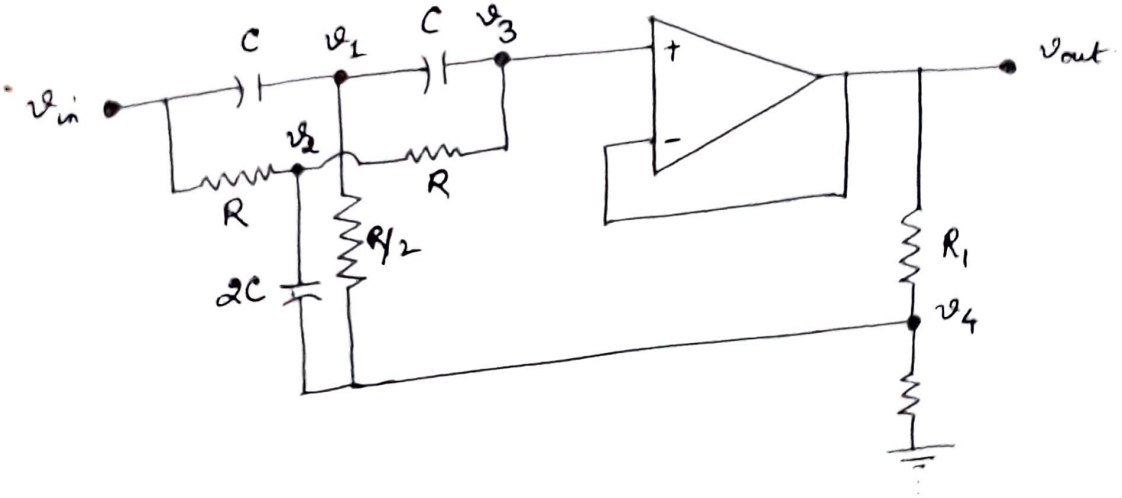
c) For the cases where applicable, calculate the rise time, settling time and %OS for your examples.



(a)



(b)



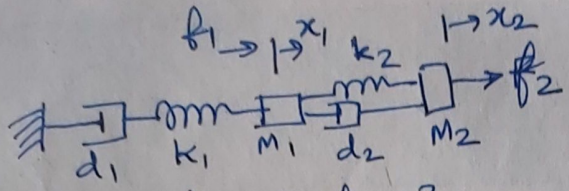
(c)

4(a) The switch K in Fig(a) is initially closed at 'a' till steady state is attained. Then at $t = 0$, it is thrown to position 'b'. Obtain $v_{out}(t)$ for $t > 0$ using the Laplace transforms suitably.

(b) For the ckt in Fig (b), obtain the transfer function $\frac{V_{out}(s)}{V_{in}(s)}$.

(c) For the active network in Fig(c), write down suitable eqns in transformed variables, using KCL at nodes 1, 2, 3 and 4. Hence, obtain $\frac{V_{out}(s)}{V_{in}(s)}$

Q3a.



forces f_1 & f_2 are zero when all positions (x_1 & x_2) & velocities are zero.

$k_1 = 5$, $k_2 = 12$, $d_1 = 10$, $d_2 = 3$

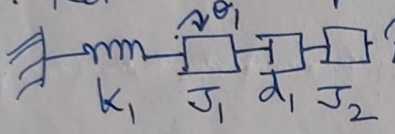
(d ≡ dampers). All in SI units.

a.1 Find transfer function from f_1 to x_2.

a.2. Find transfer function from f_2 to x_1

a.3. Write units for each of k_i f_i, x_i, d_i explicitly.

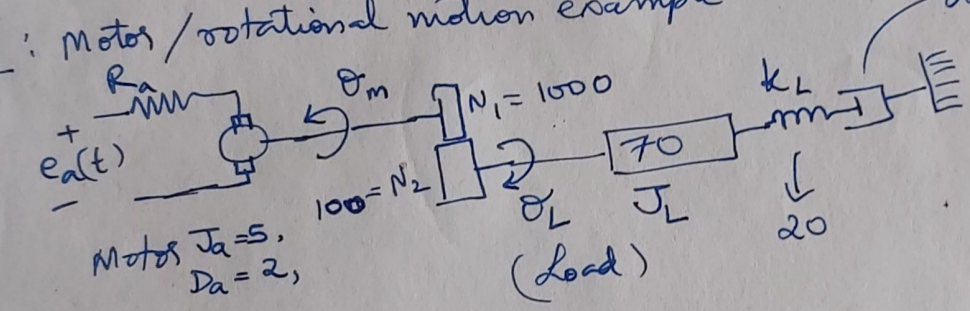
Q-3b: Rotational spring/mass/(moment of) inertia/Torque.



b.1 List units of k_1, d_1, θ_2, J_2, J_1 (SI units)

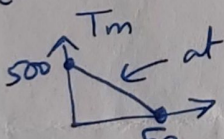
b.2 Find transfer function from T_2 to $\dot{\theta}_2$ (rate of change of θ_2)

Q-3c: Motor/rotational motion example.



All units are SI.

Ra, ~~Kt~~ to be found



at $e_a = 100V$.

Find the transfer function from armature voltage $e_a(t)$ to $\theta_L(t)$ (load angle).