1. As the figure, the system with two blocks, mass M_1 and M_2, moves on the surface without any friction. Suppose the force is f(t) and the spring parameters are K_1, K_2, and K_3 and the damper is B_1. Find the transfer function $X_2(s)/F(s)$ of the dynamic system. (20%)
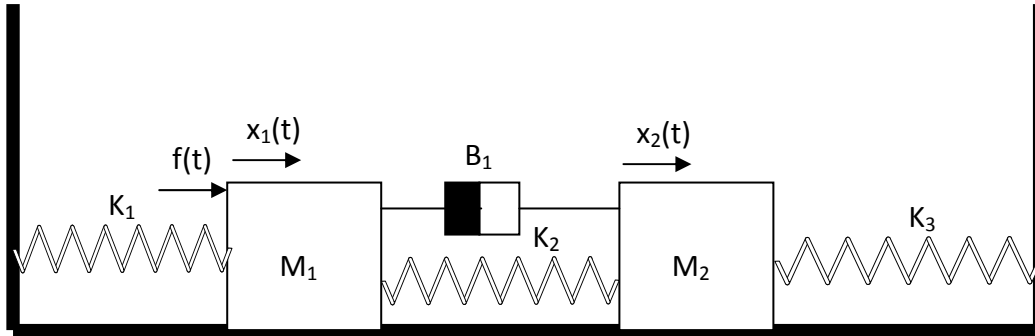
2. Find the transfer function Y(s)/R(s) for the block diagram as follows. (20%)
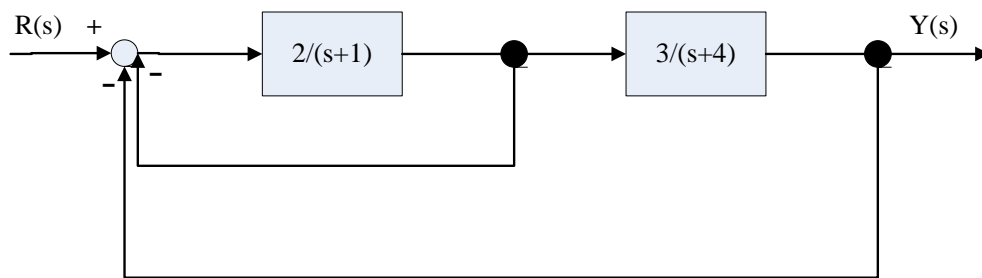
3. The z-transform of signal x[n] is $X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$, determine the z-transform of signal $x[n] = a^n u[n]$ and depict the region of convergence (ROC), pole and zero in z-plane. (20%)

4. The state equation of system is $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -4 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$, design a state feedback controller $u(t) = -\begin{bmatrix} k1 & k2 \end{bmatrix} x(t)$ where the poles are located at -2 and -6. Determine the values of k1 and k2 ? (20%)

5. Suppose the system dynamic equation is $10\ddot{x} + 2\dot{x} + 6x = 5$. Please find the state equation and the output equation into the form as $\dot{x}(t) = Ax(t) + Bu(t), \ y(t) = Cx(t)$. (20%)