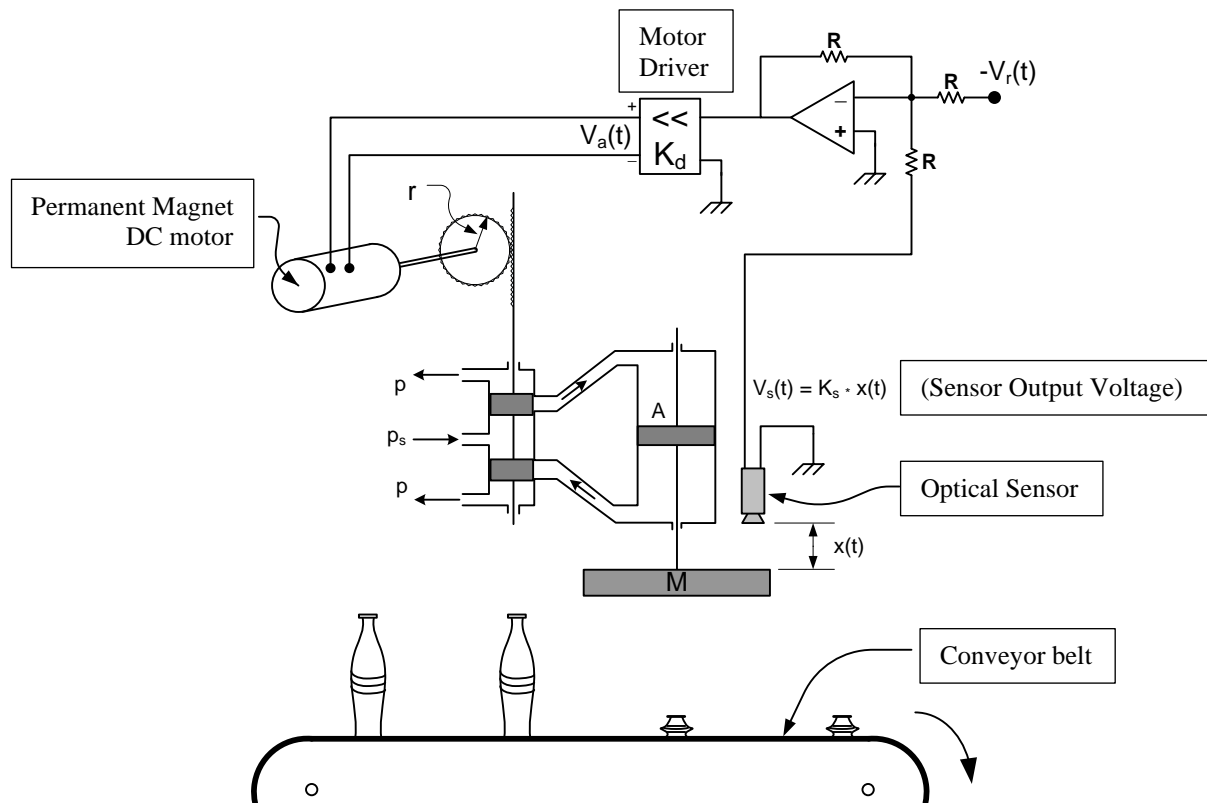


QUESTION A conveyor system compresses empty plastic bottles using a hydraulic piston as they move along a conveyor belt. When the piston is not in contact with any plastic bottles, the motion of mass M is controlled, with $V_r(t)$ as the input (reference voltage or control signal) and $x(t)$ as the output (piston position).

- Draw a *block diagram* of the system.
- Implement the system model in *MATLAB Simulink* based on the diagram from (a).
- Develop an equivalent model in *MATLAB Simscape*.
- Choose **appropriate numerical values** for the system parameters and simulate the system:
 - In Simulink,
 - In Simscape, and
 - Compare the simulation results from *Simulink* and *Simscape*.

P.S. Valve and piston masses are negligible. No need to model the conveyor belt part of the system.



R_a : Motor armature resistance [Ω]	r : Gear radius [m]
L_a : Motor armature inductance [H]	J_D : Gear inertia [$\text{kg}\cdot\text{m}^2$]
K_b : Motor back EMF constant [$\text{V}/(\text{rad/s})$]	ρ : Fluid viscosity [$\text{kg}/(\text{m}\cdot\text{s})$]
J_m : Motor inertia [$\text{kg}\cdot\text{m}^2$]	p_s : Input pressure [Pa]
B_m : Motor viscous friction [$\text{kg}\cdot\text{m}^2/\text{s}$]	p : Output pressure [Pa]
K_t : Motor torque constant [$\text{N}\cdot\text{m}/\text{A}$]	A : Piston surface area [m^2]
K_d : Motor driver gain	M : Pressing mass [kg]
K_s : Optical Sensor gain	K_x, K_p : Valve parameters