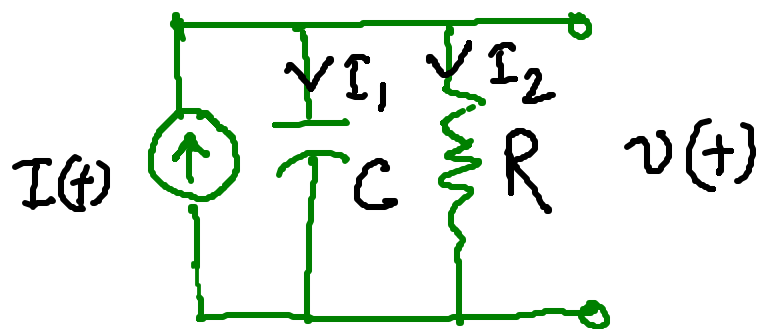


What is feedback?

— Feedback exists means a closed sequence of cause-and-effect relationship exists.

Examples:

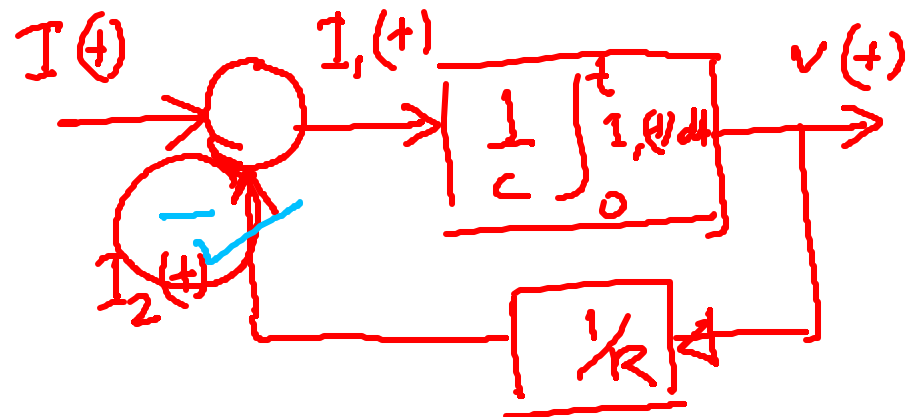
Ex 1.



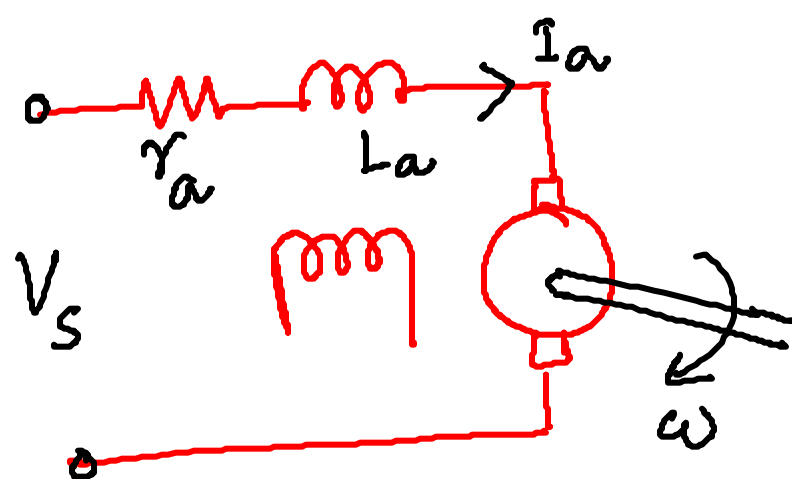
$$I_1(t) = I(t) - I_2(t) \quad \checkmark$$

$$\checkmark v(t) = \frac{1}{C} \int_0^t I_1(t) dt$$

$$I_2(t) = \frac{v(t)}{R}$$



Ex. 2 DC Machine



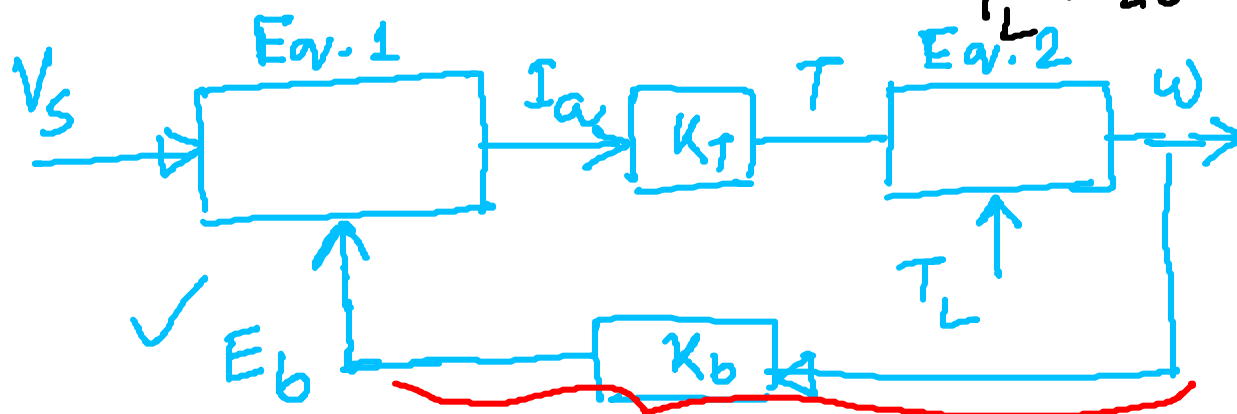
$$\underline{V_s = I_a r_a + L_a \frac{dI_a}{dt} + E_b} \quad (1)$$

$E_b = \text{back e.m.f.}$

$$E_b = k_b \omega$$

$$T = K_T I_a = J \frac{d\omega}{dt} + B\omega + T_L$$

$$T_L = \text{Load torque} \quad (2)$$



V_s : Supply DC voltage

r_a : armature resistance

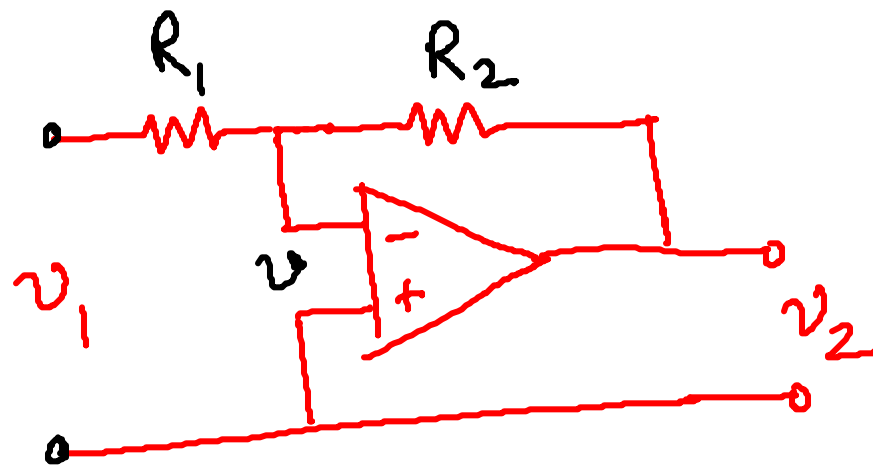
L_a : armature inductance

ω : angular speed

I_a : armature current

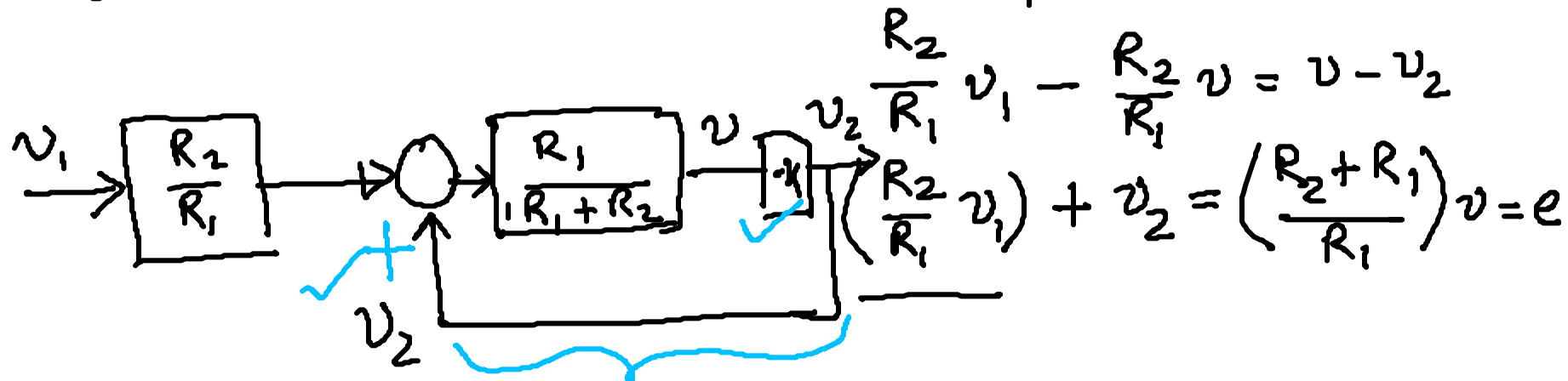
K_T, K_b : Constants

Ex. 3



$$\underline{v_2 = -k v}$$

$$\frac{v_1 - v}{R_1} = \frac{v - v_2}{R_2}$$



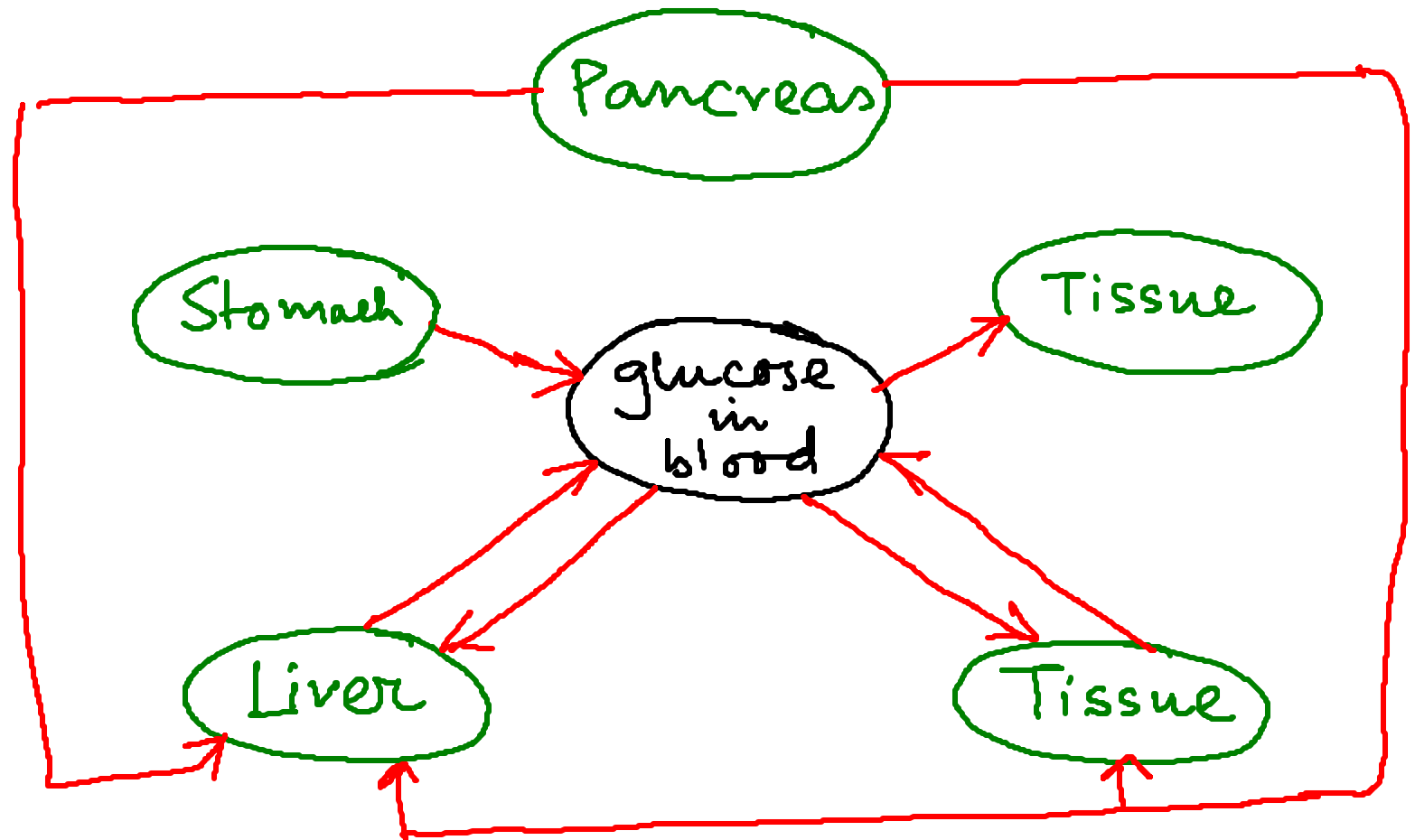
$$\frac{R_2}{R_1} v_1 - \frac{R_2}{R_1} v = v - v_2$$

$$\left(\frac{R_2}{R_1} v_1 \right) + v_2 = \left(\frac{R_2 + R_1}{R_1} \right) v = e$$

Ex. Insulin-glucose dynamics

- blood glucose concentration is kept within a narrow range 0.7 - 1.1 g/L
- influenced by many factors like food intake, digestion and exercise.
- Glucose concentration is maintained by the Pancreas, which secretes insulin and glucagon.
- When glucose level is low - Glucagon is released into the bloodstream - it acts on the cells in the liver that releases glucose.

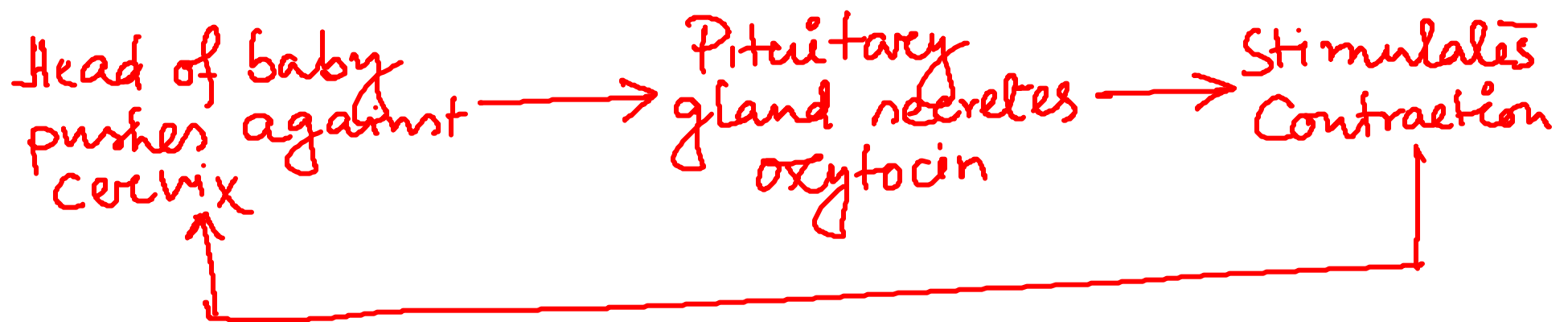
- When glucose level is high - Insulin is secreted - glucose level is lowered by causing the liver and other cells to take up more glucose.



Some more examples:

- Web server control
- Control of vehicle dynamics
(Human in loop)

- Child birth



Positive feedback

- Flexible structures

- Vibration control against spill-over dynamics
- Collocated position sensor and actuator is used with positive feedback.