Figure 1: DC motor equivalent circuit. $T_{load}$ is a combination of the internal torque $T_{in}$ (due to gear box) and the torque $T_{ext}$ applied to wheel externally

1) Write the equation relating angular wheel frequency $\omega$ and the encoder frequency $f_{enc}$. That is, find the constant $K_{enc}$ such that $\omega = K_{enc} \cdot f_{enc}$. You will need to review lecture slides in order to answer this question.

2) Assume that $V_{DC}$ and $I_{DC}$ are constant DC values and the wheel is rotating at constant angular frequency $\omega$. Find an expression for motor parameter $k$ as a function of $V_{DC}$, $I_{DC}$, $R_{M}$ and $f_{enc}$. You may first solve in terms of $\omega$, and then use question 1 equation to put the answer in terms of $f_{enc}$.

3) Assume again that $V_{DC}$ and $I_{DC}$ are constant DC values. When a motor wheel is locked in place, the angular frequency of the motor is forced to zero, $\omega = 0$. Under these assumptions, redraw the equivalent circuit in Figure 1 and simplify as much as possible. Given $V_{DC} = 1$ V, a DC current of $I_{DC} = 0.5$ A is measured. Calculate motor winding resistance $R_{M}$. 