LEGO NXT Motorized Winch-and-Cart Questions

DC motor theory and equations were derived in lectures. Labs detailed data acquisition (e.g. capturing motor velocities versus time) and setups for observing running current and torques. Lastly, Simulink examples were illustrated for simulating motor response. This project serves to document results and hence reinforce one's understanding of motor characterization.

1. Complete the following and derive the following equations (10%)

   A. Winch wheel radius: _____

   B. Mechanical power in Watts. Note: your velocity data was captured in RPM

2. From above and your captured and observed data to complete the table below (20%)

Cart Mass [Kg]	Payload m_{load} [Kg]	Total Load Mass [Kg]	Current I [A]	Velocity ω [RPM]	Torque {Nm}	Power [W]
	0.00					
	0.10					
	0.20					
	0.30					
	0.40					
	0.50					
	0.60					
	0.70					

3. From your table above, for your NXT motor, what are the (15%):

   A. Stall current in Amps?
   B. Stall torque in Nm?
   C. Maximum mechanical power in Watts?
   D. At what current in Amps is the mechanical power a maximum? How does this value compare to the stall current?
   E. At what torque in Nm, is the mechanical power a maximum? How does this value compare to the stall torque?

4. For the velocity corresponding to maximum mechanical power, provide a plot of velocity (in RPM on y-axis) versus time (on x-axis). Annotate on this plot (with values), the following (15%):

   A. The steady-state velocity in RPM
   B. The rise-time in seconds
   C. The transient velocity in RPM (which is 63.3% of the steady-state velocity value)

5. Based on your answers in Question 5, derive the open-loop transfer function relating the motor level (in %) and motor velocity (in RPM). Hint: recall how Equations (5) and (6) were derived in lecture PID notes (20%)

6. Use Simulink to plot your open-loop transfer function from Question 5. Provide a side-by-side comparison of your Simulink scope plot with your actual experimental data (20%).