

PH132 Physics II: Train Project Electrical Description and combination with Previous Mechanical Description Online

Part 1: Describe components of a DC motor referring to figure 1. (single coil simplification)

Figure: Schematic of a single coil portion of a DC motor. (10 pts.)

Motor Torque Equation Development:

- a) Show how $F = il \times B$ and $\tau = r \times F$ result in a motor torque that includes the loop area, the magnetic field, the current, and the loop orientation angle. (30 pts.)
- b) Show what happens when the single loop motor is extended to N loops and Different orientations of coils. (you may include an additional figure here. (10 pts)
- c) Show your final torque equation. This should be in terms of the applied track voltage, V and the track resistance R. (5 pts)

Part 2: Combination of Mechanical and Electrical Theory. By substituting the motor torque from your electrical description into the mechanical theory, show how you arrive at a single theoretical description for your train.

- a) Show the full model or equation of motion for your train. Simplify this model by writing it in terms of the steady state velocity, $v_{ss} = B$, your trains time constant, A, and the velocity as a function of time, $v(t)$, and the acceleration, $\frac{dv}{dt}$. (25 pts)
- b) Show the linear relationship of the v_{ss} with applied voltage, V. (10 pts.)
- c) What is your trains time constant in terms of the equivalent rotational inertia, the radius of the wheel and the viscous friction coefficient? (10 pts.)