Sim Lab 8 Part 2 – Efficiency Revisited

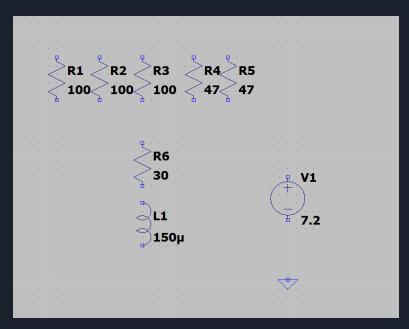
Prerequisites

- Please make sure you have completed the following:
 - LTspice tutorial part 1-4

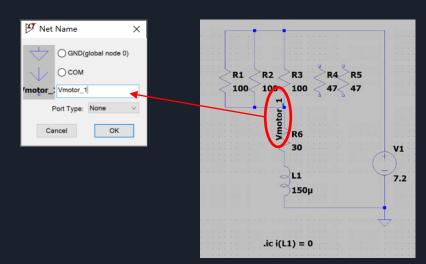
Learn ing Objectives

- Build circuits that control the motor speed with resistor network and with MOSFET using TSpiceXVII.
- 2. By calculating the power efficiency of two speed control circuits, learn that the use of MOSFET in a speed control circuit can increase the power efficiency.

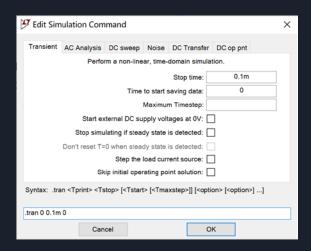
 First, place the components as the following figure. For convenience, we use a resistor in series with an inductor to model the motor. Set the values of resistors, the inductor and the voltage source like the figure.

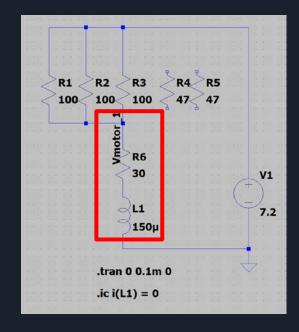


- Next, connect the circuit as the following figure. We first connect the left three 100Ω resistors to the circuit. Also, add a label net called "V motor_1" and place it right above R₆.
 We want to monitor the voltage across the motor in this way.
- At the same time, like what we did to a capacitor in previous labs, we also need to set initial conditions for an inductor. Click "Edit" -> Spice Directive -> set ".ic i(L1) = 0".



- Next, set the simulation condition as the left figure. We are ready to start the simulation.
- The reason to set the stop time as 0. Ins is to observe the change of Vmotor_1 through time from a transient state to steady state.







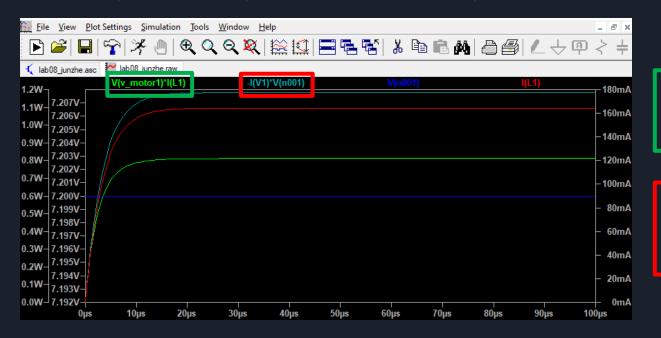
- Run the simulation.
- Plot Vmotor_1 and the current flowing through R₆. Using the steady state voltage value of Vmotor_1 and steady state current value of I(R), you can compute power (P₁) that the motor consumes. Assume no DC power consumed by the inductor.
- You can also compute the power provided by the voltage source.



- Calculate the efficiency η₁.
- Recall the efficiency of the motor = $\frac{Power\ Consumed\ by\ Motor}{Power\ Supplied\ by\ Voltage\ Source}$

Plot of Power Consumed and Power Supplied

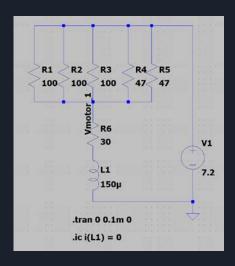
- LTSpicecan help plot the power consumed by the motor and power supplied to the total circuit.
- Plot these powers, both as positive values for easier comparison.



Power consumed by motor

Power supplied by voltage source (absolute value)

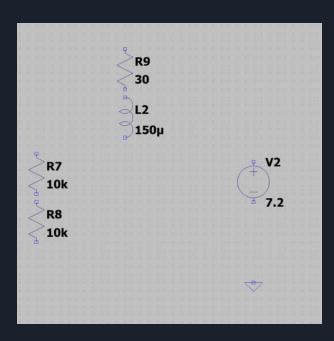
• Next, connect the two 47 Ω resistors to the circuit and repeat the previous procedures again. Plot the new V motor_1 and current flowing through the motor.



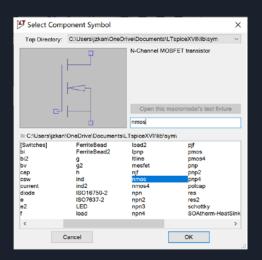


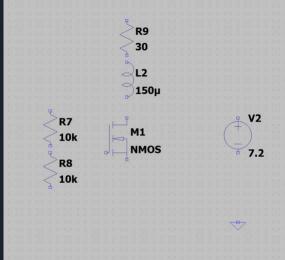
- Plot the power consumed by the motor now (P) and record its value.
- Compute new power efficiency, η_2 . Compare it with η_1 . W hat do you find? Explain why the efficiency improved.

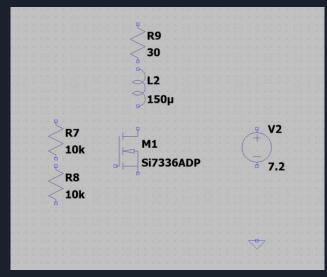
- Let's now simulate the speedcontrol circuit with the MOSFET transistor.
- Placethe components as follows.



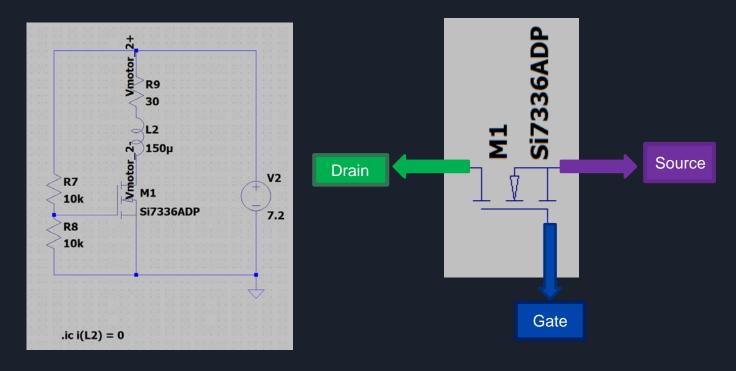
- In components, type 'hmos' to find the n-MOSFET we will use in this lab. Place it as the
 middle figure. Then right click M1-> click "Pick New MOSFET"> choose "Si7336ADP".
 Note that if you can't find this model easily, you can choose another and then edit by hand.
- Your circuit should look like the right figure now.
- Note that we use two separate resistors to model the potentiometer. The voltage across will also become the gate voltage of the rMOSFET that will "turn on" the MOSFET.







• Connect the circuit as in the following figure. Add another two label nets "Vmotor_2+" and "Vmotor_2-" and put it right above R_0 . Set the same initial condition for L_2 : "ic i(L2) = 0".



Start the simulation. Plot Vmotor_2+, Vmotor_2-, I(R9), I(V2); add a new trace with the expression of "V(vmotor_2+)-V(vmotor_2-)" to represent the voltage across the motor.



• Calculate the power consumed by the motor (\Re) and the power efficiency η_3 . Compare η_3 with η_1 and η_2 . W hat do you find? Give your explanation.

Save Your Files

Save your plots and circuit schematics and submit them long with the answered questions.