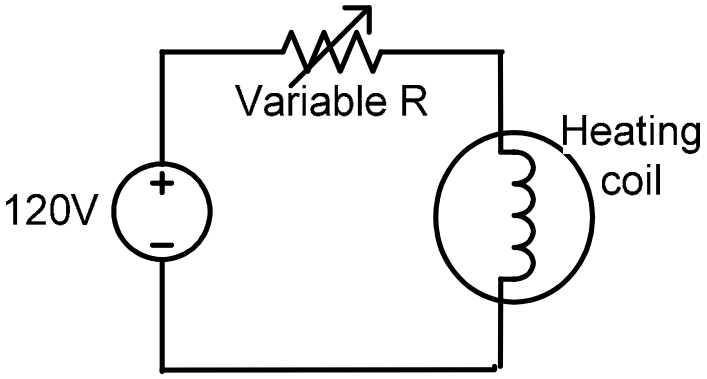
ECSE 200: Fundamentals of Electrical Engineering

Assignment 2

Winter 2006

Question 1

A heating coil is rated 600W at an input voltage of 120V DC. A variable resistor is inserted in series with the coil in order to control its power. What range should R have for the power consumption in the coil to range from 150W to 600W?

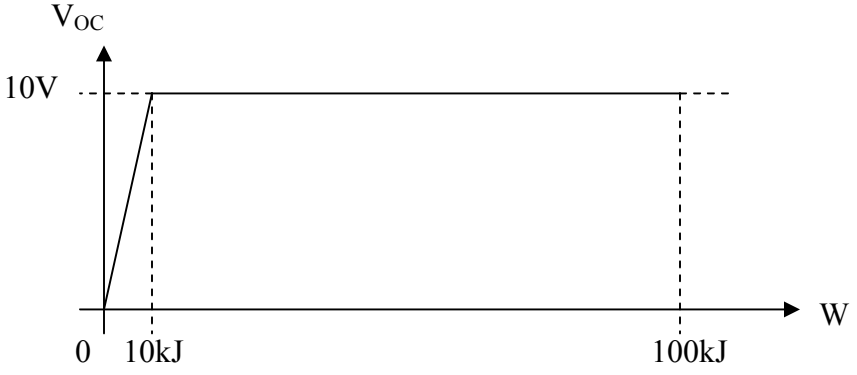


Question 2

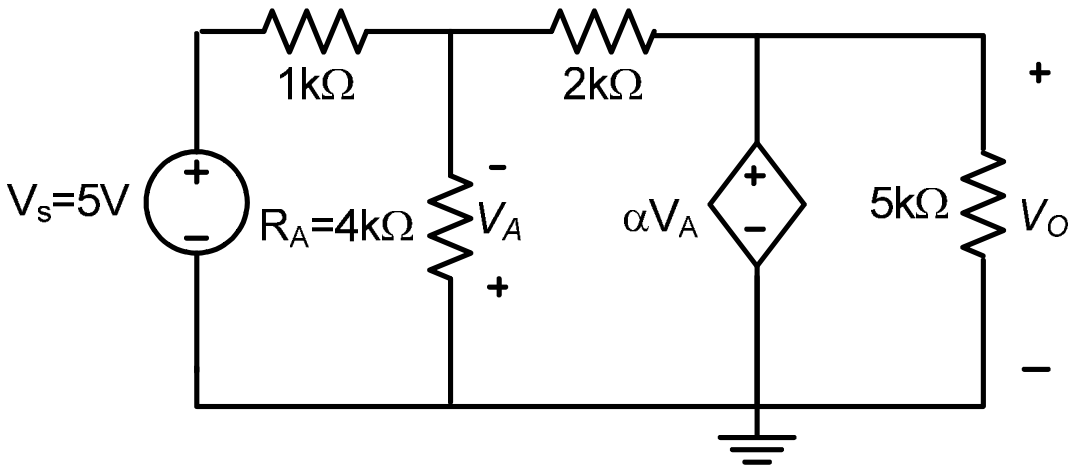
Consider a linear battery that is characterized by the stored energy versus open-circuit terminal voltage plot given below. Assume that the battery is fully charged (100kJ) and that it has negligible open-circuit losses. A careful experiment has shown that if this battery is connected directly to an OHMIC 2Ω resistor, the HEAT output from the resistor will be CONSTANT for exactly 5 hours, and then it will start to REDUCE.

a) Calculate the "internal resistance" value(s) that could be used to model this battery.
b) Find how much time it would take for this battery to discharge from 100kJ to 10kJ, if an IDEAL SHORT-CIRCUIT was connected across the battery terminals (instead of 2Ω).

Hint: Think about how you plan to solve this problem before you start!

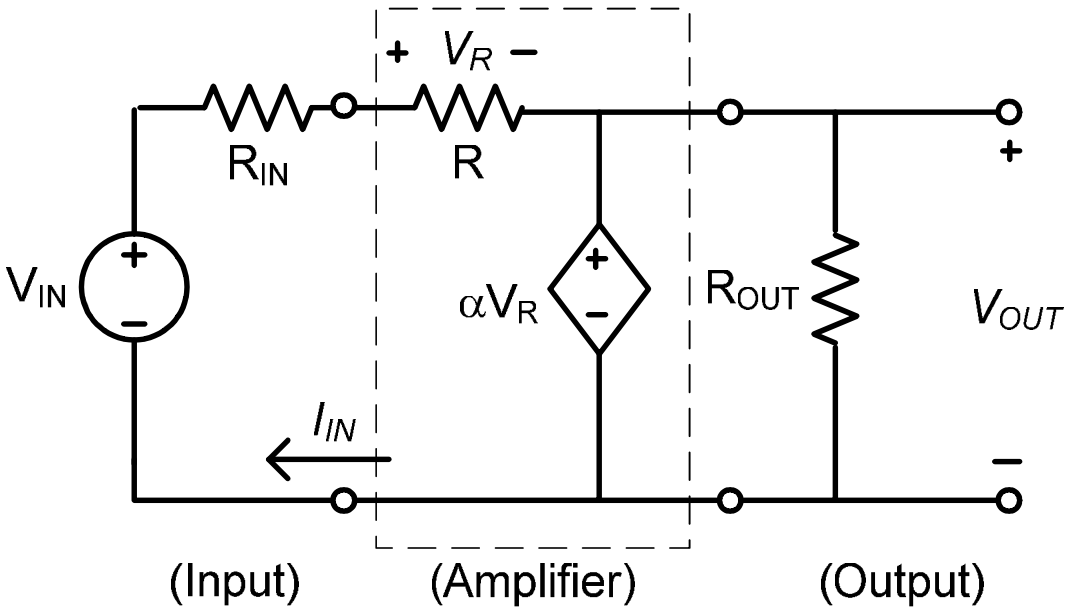


Question 3
Consider the linear circuit shown below and answer each of the following questions:



a) Find an expression for the value of the voltage V_A, specified as a function of α.
b) Find the voltage gain of the circuit, defined by V_o/V_s, in the limit as $\alpha \rightarrow \infty$.
c) Find the power supplied by the controlled source in the limit as $\alpha \rightarrow \infty$.

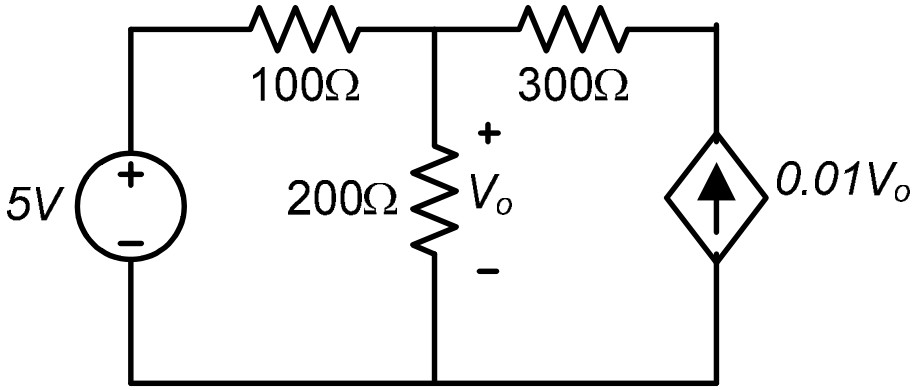
Question 4
Consider the three-stage amplifier circuit provided below, and answer the following:



a) Find an expression for the current I_{IN}, in terms of the parameters V_{IN}, R_{IN}, R and α.

b) Find an expression for the voltage gain V_{OUT}/V_{IN}, in terms of R_{IN}, R and α.
c) Find the limit voltage gain V_{OUT}/V_{IN} that results when $R \rightarrow \infty$ and $\alpha \rightarrow \infty$.

Question 5
Consider the circuit provided below and answer each of the following questions:



a) Prove that the controlled source acts like an ohmic device.
b) Find the equivalent resistance of the controlled source.
c) Find the power supplied by the controlled source.

Question 6
Consider the circuit model for a storage battery shown below. Calculate the values of R_1 and R_2 that make the battery dissipate 50mW under open-circuit conditions, and 48W under short circuit conditions.