This is a closed-book examination, but you may use a hand-held calculator. Do all work in the bluebook provided, clearly indicating your answers. Partial credit is more likely for neat, well-organized work. Put your name on your exam booklet. The four problems are weighted equally.

In your answers, specify units and do not overstate or understate precision of numerical values.

1) Using nodal analysis, find an expression for the voltage $v$ of the circuit below. Note that $i_s = ki_a$ is a dependent current source. Fully explain your methods.

$$i_a \quad v \quad i_s$$

$$R_a \quad R_c \quad R_b$$

$$V_a \quad i_s \quad V_b$$

$$i_s = ki_a$$

It is unnecessary to reduce the complexity of your algebraic expression.

2) The 10x resistive voltage divider in an electronic circuit is specified to be accurate to ±3%, that is, the ratio of output to input voltage must equal 0.10 (±0.003). (a) What is the ratio of the resistor values? (b) Use worst-case analysis to determine if it possible to achieve the specified ±3% tolerance requirement on the divider ratio using ±2% resistors?

HINT: An easy way to do this problem is to select specific numerical values (in Ω) for the two resistors that achieve the voltage ratio, and then perform the worst-case analysis using these values and their ±2% tolerances.
3) For the resistive circuit below, use the superposition principle to find an algebraic expression for the current $i$ flowing through the resistor $R_L$. Thoroughly explain your method in words and with appropriate circuit diagrams.

\[ \text{Diagram of circuit with } V_o, R, R/2, I_o, R_L. \]

*Do not use source reduction to solve this problem.*

4) For the circuit below, use the method of source reduction repeatedly to solve for the current $i$. (a) Find the simplest Norton equivalent for the circuit to the left of the heavy grey line. (b) Obtain a numerical value for the current $i$.

\[ \text{Diagram of circuit with } 1 \Omega, 2 \Omega, 3 \Omega, 1 A, 1 A. \]

*Do not use superposition to solve this problem.*