9 Personal Solar Torch Test Jig

A *Personal Solar Torch* (PST) test jig is to be designed. Upon placing the PST into the jig, two LEDs (green and red) will illuminate indicating the status of whether various parts of the PST are working as intended.

Consider the conditions for the green LED:

(i)   It will not be illuminated if the battery is not present.

(ii)   It will be illuminated if the battery is present and the PST can be turned on/off.

(iii)   It will be illuminated if the battery is present and the energy harvester is working in sunlight.

Consider the conditions for the red LED:

(i)   The red LED will be illuminated if the battery is present but the PST cannot be turned on/off.

(ii)   The red LED will be illuminated if the battery is not present but the energy harvester is working in sunlight.

(a)   Identify the independent variables (the inputs) and the dependent variables (the output quantities whose value depends on the inputs). Assign the letters A, B, C for the inputs, and G and R for the outputs.

(b)   Draw a truth table – tabulate all the possible combinations of values for the independent variables, and add two columns for the dependent variables.

(c)   Establish a Boolean expression for each of the dependent variables.

(d)   Minimise the Boolean expressions using Boolean algebra and theorems.

(e)   Draw 2 circuits using AND, OR and NOT logic gates to implement the expressions.

(f)   Rationalise the gate type by converting the circuits so they use only NAND gates.