MorphoCH22
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Problem Statement

An automobile controller receives several sensor inputs from various engine systems. Four of the sensors are: Coolant Temperature (CT) that outputs a “1” when the coolant temperature exceeds 200 degrees; Coolant Low (CL) that outputs a “1” when the coolant level falls below 60% of capacity; Oil Temperature (OT) that outputs a “1” when the oil temperature exceeds 180 degrees, and Oil Low (OL) that outputs a “1” when the oil level falls below 75% capacity.

Design and implement a warning light system that:

Illuminates a yellow light whenever any of the following are true:

- Only the Coolant Level is low
- Only the Oil Level is low
- The Oil Temperature is too high and the Oil Level is OK
- The Coolant Temperature is too high and the Oil Level is too low

Illuminates a Red light (using the other LED package) whenever any of the following are true:

- The Coolant temperature is too high and the Coolant level is too low
- The Oil Temperature is too high and the Oil Level is too low
- The Coolant and Oil Temperatures are too high at the same time
- The Coolant and Oil levels are too low at the same time that the Coolant Temperature is too high and the Oil Temperature is OK.

Analysis

There are four conditions (inputs) to consider; Coolant Temperature (CT), Coolant Low (CL), Oil Temperature (OT), and Oil Low (OL). Based on these conditions, a yellow or red light may be turned on to indicate that there is an issue with the automobile. The conditions and the light functions can be represented using sum of products (SOP) expressions, where each point can be considered a product. These can further be simplified using various axioms and theorems to make expressions that are more optimized. Once the simplified expressions are created, it can be applied in a HDL program.

$$Y = \overline{CT} \cdot CL \cdot \overline{OT} \cdot \overline{OL} + \overline{CT} \cdot \overline{CL} \cdot \overline{OT} \cdot OL + OT \cdot \overline{OL} + CT \cdot OL$$

$$Y = \overline{CT} \cdot CL \cdot \overline{OL} + \overline{CL} \cdot \overline{OT} \cdot OL + OT \cdot \overline{OL} + CT \cdot OL$$

$$R = CT \cdot CL + OT \cdot OL + CT \cdot OT + CT \cdot CL \cdot\cdot \overline{OT} \cdot OL$$

$$R = CT \cdot CL + OT \cdot OL + CT \cdot OT$$