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Educational aspects of the Circuit Warz

Circuit Warz is a pedagogically and theoretically sound serious game designed to teach advanced electronic/electrical circuit theory where students must use and apply their knowledge and understanding of circuit theory to bias a series of electronic circuits successfully to complete the game. The game is designed to ensure a high level of user engagement and replayability with a competitive leaderboard element and analytics to measure student retention. To complete the game successfully the student needs to have a clear understanding of both the underlying circuit theory and its application. The figure below shows the level type, player objective on each level, the related theory and the learning outcomes for each level.

The game has main modes, training levels (7 x individual training levels available to play on line on this website) and the main game. The training levels allow the students to practise and learn the theory. The main game is effectively a form of assessment.

Circuit Warz uses a summative and formative approach to assessment. Formative assessment is stealth based/implicit and carried out throughout the game, continuously monitoring student progress and providing feedback through the HUD and Generator status boards. This approach has a number of advantages as it can be carried out in real time without interrupting the user's flow. Elements of formative assessment include the time taken to complete level(s) and score achieved per level.

Summative assessment is carried out at the end of the game with an overall total accumulated score and awarding of in-game achievements and badges to the player e.g. achieving a score of 100% on a level within a constrained time period. A global leader board adds a competitive element to the game allowing the student to benchmark their performance against others.

Level/Circuit	Objective	Theory	Learning outcomes
Level 1 Series/parallel	Solve for R1 given Vi,R2,R3 to get required value Vo	$V_o = \frac{R_{eq} \times V_{in}}{R_{eq} + R_1}$	Parallel and series circuits. Equivalent resistance. Circuits and current flow.
Level 2 RC filter	Solve for R1, C to get target cut off f_c	$f_c = \frac{1}{2\pi RC}$	RC circuits and cut off frequencies Low/high pass filters.
Level 3 Graetz Bridge	Align diodes. Solve for C given Vpp, R, f to get target output V	$C = \frac{Vpp}{2 \times R \times f \times V_{smooth}}$	Convert AC to DC. Ripple reduction using capacitors. Diodes in rectification.
Level 4 Wheatstone	Solve for Rx given R1, R2, R3 and Vpp. Balance bridge Vg=0	$V_g = V_{pp} \times \left(\frac{R_2}{R_1 + R_2} - \frac{R_X}{R_3 + R_X}\right)$	Components/operation of bridge. Find unknown resistance value using circuit.
Level 5 Summing amplifier	Solve for R0 given R1,R2,R3 to achieve target Vout	$V_{out} = -R_0\left(\frac{Ve_1}{R_1} + \frac{Ve_2}{R_2} + \frac{Ve_3}{R_3}\right)$	Op amps in summing amplifiers Relationship input/output Voltage Role of feedback resistor (R0)
Level 6 Transistor switch	Solve for R*in* and R*l* given Vpp, Vin to achieve target IC.	$I_C = \frac{V_{pp} - V_{CEsat}}{R_l}$	Understand saturation/cut-off in transistor as switches. Relationship between RC and IC
Level 7 Oscillator	Solve for R2, R3 and C to achieve target frequency and V*pp*	$f = \frac{1}{2 \times R_3 \times C \times \ln\left(1 + 2\frac{R_1}{R_2}\right)}$	Convert DC source to (AC). Compute oscillation frequency from components.