Assessment for Analog Computer Exploration: "Hello World" Program

Objective: Assess student understanding of the key concepts and procedures involved in programming an analog computer to model a simple system (radioactive decay).

Instructions: Answer the following questions to demonstrate your comprehension of the provided information about analog computers and their programming.

Part 1: Multiple Choice (1 point each)

1. What is the main difference between programming an analog computer and a digital computer? a) Analog computers use a pseudo-English language like Python. b) Analog computers use electrical components to model systems. c) Analog computers are slower than digital computers in all cases. d) There is no difference; they both use the same programming languages.
2. Which of the following is NOT a typical component used in analog computers? a) Integrator b) Multiplier c) Adder d) Hard drive
3. What type of mathematical equation is typically used to model systems for analog computer programming? a) Linear equation b) Differential equation c) Quadratic equation d) Trigonometric equation
4. What does the lambda (λ) symbol represent in the context of radioactive decay modeling? a) Initial amount of radioactive material b) Rate of radioactive decay c) Half-life of the material d) Time constant
5. The output waveform of the "Hello World" program on the oscilloscope represents: a) Random electrical noise b) A constantly increasing signal c) An exponential decay curve d) A straight line

Part 2: Short Answer (5 points each)

1. Briefly explain the role of the integrator in the "Hello World" program (radioactive decay model).
2. Describe the concept of a feedback loop in the context of the analog computer program.
3. How can the programmer use the THAT interface to change the initial amount of radioactive material (N_0) in the model?
4. Explain the relationship between the lambda (λ) coefficient and the half-life of the radioactive material being modeled.

Part 3: Application (10 points)

Imagine you want to model the growth of a bacterial population using an analog computer. Describe the steps you would take, including:

- The type of differential equation you would use to represent bacterial growth.
- The electrical components on the THAT you would utilize.
- How you would interpret the resulting waveform on the oscilloscope.

Grading Rubric:

- Multiple Choice (20 points total): 1 point for each correct answer.
- Short Answer (20 points total): 5 points for each complete and accurate answer.
- Application (10 points total): Points awarded based on the clarity and correctness of the explanation for each step.

Answer Key

Part 1: Multiple Choice

1. b) Analog computers use electrical components to model systems.
2. d) Hard drive
3. b) Differential equation
4. b) Rate of radioactive decay
5. c) An exponential decay curve

Part 2: Short Answer

1. The integrator in the radioactive decay model calculates the integral of the rate of decay (N') to determine the amount of radioactive material (N) present at any given time. It essentially accumulates the changes in the amount of material over time.
2. A feedback loop in this context occurs when the output of a system (in this case, the calculated amount of radioactive material, N) is fed back into the system as an input to influence the subsequent output. This creates a continuous cycle of calculation and adjustment.
3. The programmer can change the initial amount of radioactive material (N_0) by adjusting the coefficient associated with the initial condition input on the THAT analog computer.
4. The lambda (λ) coefficient represents the rate of decay for the radioactive material. A larger lambda value indicates a faster decay rate, while a smaller lambda value indicates a slower decay rate.

Part 3: Application

To model the growth of a bacterial population using an analog computer, you would:

- Use a differential equation of the form: dN/dt = rN, where N is the population size, t is time, and r is the growth rate.
- Utilize the following components on the THAT: integrator, multiplier, and possibly a voltage source for the initial population.
- The resulting waveform on the oscilloscope would show an exponential growth curve, where the y-axis represents the population size and the x-axis represents time.

Short Answer and Application Rubric

Criteria	Exemplary (5 points)	Proficient (3-4 points)	Developing (1-2 points)	Needs Improvement (0 points)
Understanding of core concepts	Demonstrates a deep understanding of key concepts, such as integration, feedback loops, and the relationship between analog components and mathematical models.	Shows a solid understanding of core concepts, but may lack depth in some areas.	Demonstrates basic understanding of concepts but may have misconceptions.	Lacks understanding of key concepts.
Application of knowledge	Accurately applies knowledge to the provided problem, demonstrating a clear understanding of how to model a	Demonstrates a general understanding of how to apply knowledge, but may make minor errors or omissions.	Shows limited ability to apply knowledge to the problem.	Unable to apply knowledge to the problem.

	system using an analog computer.			
Explanation and clarity	Provides clear and concise explanations, using appropriate terminology and examples.	Provides explanations that are generally clear but may lack detail or clarity in some areas.	Explanations are unclear or incomplete, making it difficult to understand the student's thinking.	Lacks explanation or demonstrates significant misunderstandings.
Critical thinking	Demonstrates critical thinking by analyzing the problem, considering alternative approaches, and justifying choices.	Shows some evidence of critical thinking but may rely heavily on provided information.	Lacks critical thinking skills, relying solely on given information.	Does not demonstrate any critical thinking.