**Lesson Plan: 3D Modeling and Printing of Rotated Curves**

**Subject**: Mathematics/Computer Science

**Grade Level**: 9-12

**Duration**: 2-3 class periods (approx. 50 minutes each)

**Objectives**:

* Students will learn how to graph functions along the x-axis using GeoGebra 3D.
* Students will understand the concept of rotating a curve about the x-axis to create a 3D object.
* Students will model 3D objects in GeoGebra 3D using specific mathematical functions.
* Students will prepare and 3D print their models to understand real-world applications of mathematical concepts.

**Materials Needed**:

* Computers with internet access and GeoGebra 3D Calculator installed or accessible online.
* Access to a 3D printer and printing materials.
* Worksheets for planning and reflection.

**Standards**: This lesson aligns with Common Core State Standards for High School Geometry, specifically visualizing relationships between two-dimensional and three-dimensional objects.

**Lesson Plan**:

**Introduction (10 minutes)**

* **Discuss** the concept of graphing functions and rotating these graphs about an axis to create a three-dimensional shape.
* **Introduce** the day’s project: creating a 3D model by rotating a function about the x-axis in GeoGebra 3D, followed by 3D printing.

**Activity Part 1: Modeling in GeoGebra 3D (50 minutes)**

1. **Demonstration** (15 minutes):
   * Demonstrate how to use GeoGebra 3D Calculator to graph a function along the x-axis using the provided example: **Function(sin(x) + 2, -3.14, 3.14)**.
   * Show how to create a 3D object by rotating the graph about the x-axis, explaining the equations **Z = sqrt((f(x)^2)-(y^2))** and **Z = -sqrt((f(x)^2)-(y^2))**.
2. **Student Practice** (35 minutes):
   * Students choose or are assigned different functions to graph and rotate.
   * Students use GeoGebra 3D to model their chosen function, applying the rotation concept.
   * Encourage exploration and adjustment to understand the impact on the 3D shape.

**Activity Part 2: Preparing for 3D Printing (50 minutes)**

1. **Exporting Models** (20 minutes):
   * Teach students how to export their 3D models from GeoGebra as STL files, suitable for 3D printing.
   * Discuss considerations for 3D printing, such as model solidity and overhangs.
2. **Printing** (30 minutes):
   * If possible, start the 3D printing process for some models during class. Due to time constraints, some printing may need to be done outside class time.
   * Discuss the printing process, including slicing software settings.

**Conclusion and Reflection (10 minutes)**

* **Reflect** on the project, discussing what was learned about graphing, 3D modeling, and the real-world application of mathematical concepts.
* **Showcase** printed models (if available) or plan for a future display.

**Assessment:**

* Evaluate student engagement and understanding through their participation in GeoGebra modeling activities.
* Assess the accuracy and creativity of their 3D models based on the mathematical functions used.
* Include reflection on the process and the mathematical concepts learned.

**Extension:**

* Challenge students to explore other mathematical functions and their rotations.
* Incorporate a lesson on the mathematics of optimizing designs for 3D printing, including material use and structural integrity.

**Notes:**

* Ensure all students have access to the necessary technology and understand how to use the GeoGebra 3D Calculator.
* Coordinate with your school's technology department in advance to ensure the 3D printer is available and functional.