Course: **Robotics and 3D Printing 101 - A Practical Guide to Robotics and 3D Printing**

Guided Learning Hours: 24

Pre-requisite: **Basic knowledge of science and technology**

Abstract

This course in Robotics and 3D Printing offers an introductory exploration into the vast world of robotics and 3D printing, focusing on fundamental concepts, principles, and practical skills essential for real world applications. Throughout this course, students will engage in theoretical discussions and hands-on activities to develop a comprehensive understanding of robotics and 3D printing systems.

Target Audience

This course is suitable for students, hobbyists, and professionals with the desire to develop foundational knowledge of robotic operations and 3D printing, acquiring both technical and practical skills for their operation.

Learning Outcomes

On completion of this course, learners will be able to:
- Explore the design and operation of a 6-axis robot arm, understanding its structural components and functionality
- Gain knowledge in programming and software control to operate the robot arm efficiently
- Analyze the range of motion and movement limits of the arm, including individual joint and planar movements
- Create programs to control the robot arm using both GUI and PDL2 programming
- Understand the basics of 3D printing, its advantages, and its role in modern manufacturing
- Familiarize yourself with various 3D printing technologies and materials, and the suitable use cases for each
- Identify the key components of a 3D printer and analyze different printer designs, including features that enhance usability
- 3D print a robotic design and create a simple program in the Arduino IDE/ESP-IDF

Course Content

1. **Introduction to Robotics**
   Robotics technology, types of robots and various real-world applications. Parts of a robot and methods of movement

2. **Creating Basic Programs**
   Creating basic programming to control the robot arm using Comau's eDO UI

3. **Understanding 3-Dimensional Coordinate Systems**
   Understanding the concepts of objects in 3D space and the coordinate systems used

4. **Robot Arm Simulation**
   Using the virtual simulator to replicate and program robotic movements

5. **Robot Programming with PDL2**
   Using the PDL2 programming language to program robotic movements for simulation

6. **Using A PDL2 Program to Control the Arm**
   Loading the PDL2 program onto the control unit and executing automatic motion

7. **Introduction to 3D Printing**
   3D printing technologies, its history and future developments. Additive/Subtractive manufacturing and their use cases.

8. **Types of 3D Printers**
   Explore the most common types of 3D printers: FDM, SLA, DLP, SLS. Explore their advantages and disadvantages.

9. **Materials used in 3D Printing**
   Explore various materials used in 3D printing such as PLA, ABS, ASA, PETG, TPU, PC etc. Identify safety and health concerns.

10. **Concepts and Terminologies**
    Common terms used in 3D printing: filament, extrusion, layer height, infill, etc

11. **Printing a Model**
    Printing a simple robotic model to be used with servo motors

12. **Assembling And Programming the Printed Model**
    Assembling the printed model with the servos and using the Arduino IDE to create a simple program for controlling it.

Assessment Criteria

In order to achieve Learning Outcome…	The Learner must be able…
Introduction to Robotics	1. To recognize the joints of a robot and their movement. 2. To use a PC or mobile device to communicate with a robot. 3. To move e.DO in joints mode.
Creating Basic Programs	1. To create programs using the eDO GUI 2. To execute programs and monitor robot movements
Understanding 3-Dimensional Coordinate Systems	1. To understand the different coordinate and reference systems used in robotics 2. To understand when to use each type of system
Robot Arm Simulation	1. To use the virtual environment for simulating robotic movements 2. To understand the importance of simulations before physically programming a robot
Robot Programming with PDL2	1. To create programs using the PDL2 programming language 2. To simulate the movement of the robot arm using the PDL2 program
Using A PDL2 Program to Control the Arm	1. To load the PDL2 program onto the control unit 2. To execute the program on the physical robot arm and monitor its motion 3. To observe safety aspects and robot limits when executing the automated motion 4. To adjust speed and use emergency stop functions when executing automatic motions
Introduction to 3D Printing	1. To understand the concepts of 3D printing and different printing technologies 2. To explore applications of 3D printing in real world scenarios

Types of 3D Printers	1. To identify the various types of printers in the industry and their use cases 2. To be able to make decisions on the types of printers suited for various projects
Materials used in 3D Printing	1. To gain an understanding of the different material types used in 3D printing 2. To be able to choose various materials for different real-world applications 3. To understand the pros and cons of each material type
Concepts and Terminologies	1. To understand 3D printing terminology 2. To be able to adjust the settings for optimal 3D printing based on the various terminologies
Printing a Model	1. To be able to use a 3D printer slicer to prepare a model for 3D printing 2. To ensure the settings are optimized before 3D printing to avoid print failures 3. To estimate the time and cost associated with 3D printing 4. To start the print process and monitor the print process
Assembling And Programming the Printed Model	1. To use a 3D printed model for a robotics build 2. To assemble the model using servo motors 3. To create a simple application for controlling the assembled model

Essential Learning Resources:

Learners will need access to a wide range of publications relating to Robotic designs and 3D printers, and a suitably equipped laboratory for practical training. Various manufacturer products, specifications and reference data would also be beneficial to learners.

Location:
SBCS Global Learning Institute

Websites
COMAU e.DO
https://www.comau.com/en/e-do

ROS - Robot Operating System
https://www.ros.org

Arduino Hardware and Kits
https://www.arduino.cc

Creality
https://www.creality.com

Prusa
https://www.prusa3d.com

Bambu Labs
https://bambulab.com/en

Elegoo
https://www.elegoo.com/collections/3d-printing

OrcaSlicer
https://github.com/SoftFever/OrcaSlicer

Ultimaker Cura
https://ultimaker.com/software/ultimaker-cura

Blender
https://www.blender.org