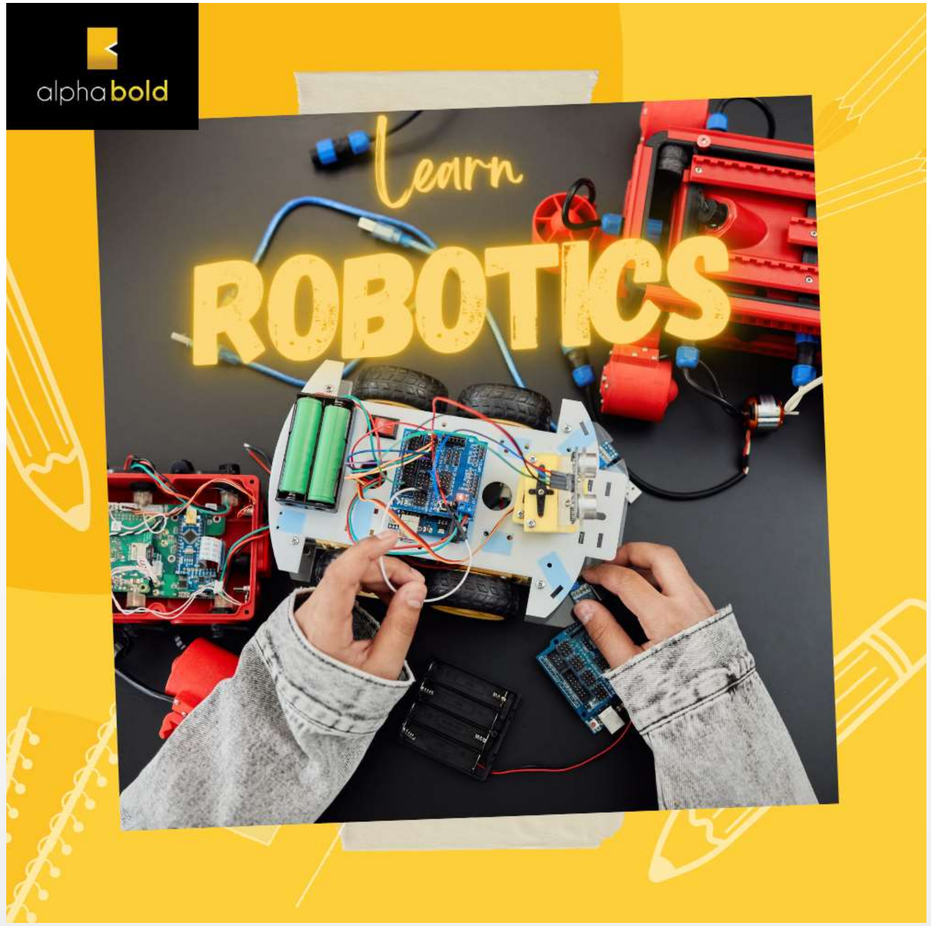
Mechanical Designing

Learn Mechanical Designing



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Learning Pathway: Robotics

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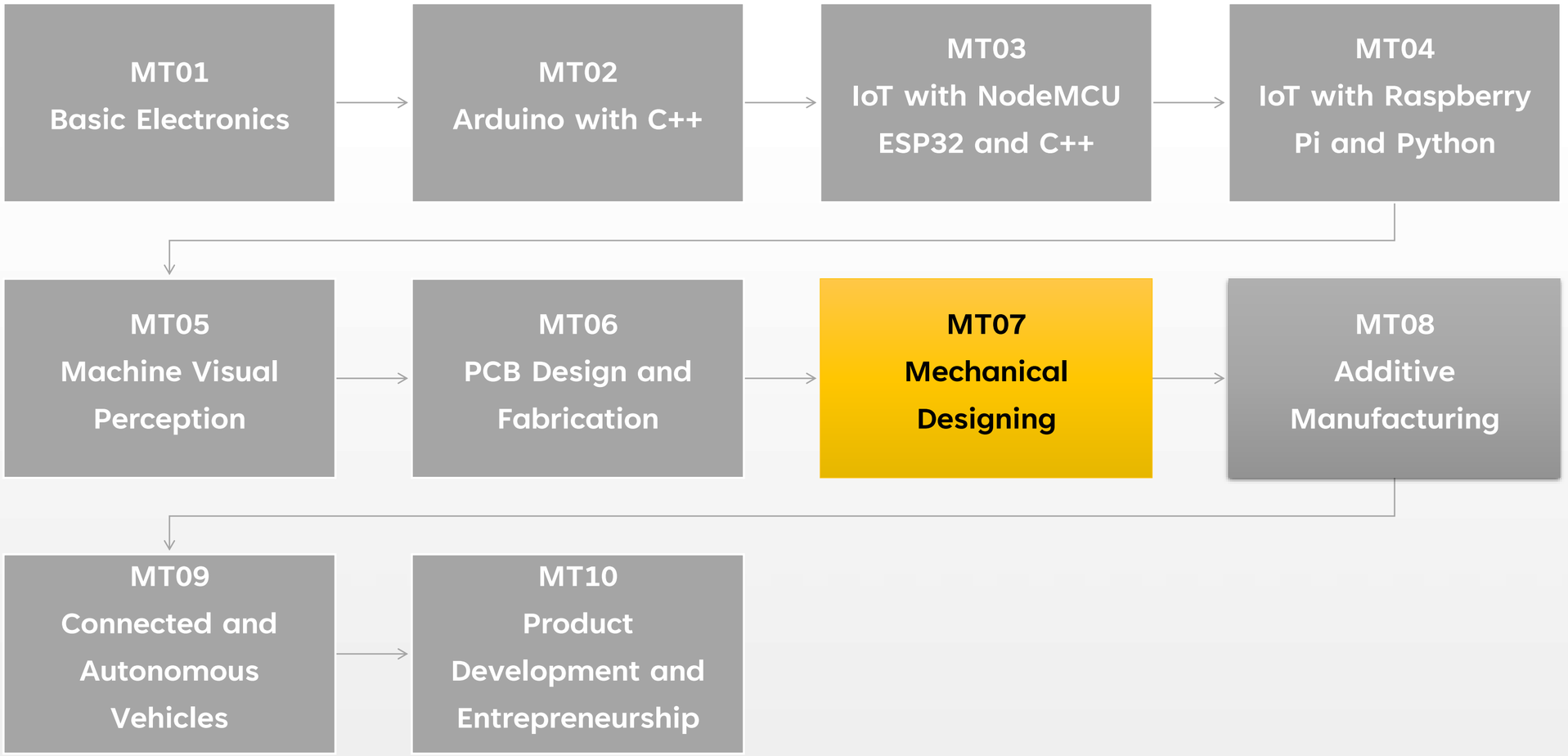

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Course Unit Details

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Overview

Robotics plays a significant role in our daily lives, particularly within manufacturing. Robots of various sizes and configurations perform tasks from simple assembly to complex welding, hazard removal, and inspection. Mechanical design is key to their physical structure, encompassing aspects like configuration, joint mechanisms, heat transfer, and more.

Understanding the principles of mechanical design is crucial for creating appealing and functional products. This course unit equips you with the essential skills and knowledge for designing mechanical components using Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) software. You'll gain a foundational understanding of 2D and 3D sketching principles, explore core modeling techniques, and delve into assembly modeling and engineering drawings. Additionally, the course will introduce you to CAM processes for generating toolpaths for various manufacturing methods.

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Aims

- Introduce fundamental concepts and tools of 2D and 3D CAD software.
- Develop proficiency in creating and manipulating geometric entities for mechanical design.
- Equip you with the ability to create and assemble 3D models of mechanical components.
- Foster the creation of professional engineering drawings based on design models.
- Introduce the principles of CAM software for generating toolpaths for manufacturing.

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Learning Outcomes

- Upon successful completion of this course unit, you will be able to:
  - Navigate the user interface of a popular 2D/3D CAD software package.
  - Utilize basic tools and functionalities within the software, including modules, toolbars, units, and dimensioning.
  - Apply 2D sketching techniques following ASTM standards, including creating entities, patterns, and applying tolerances.
  - Effectively utilize geometric constraints (vertical, horizontal, tangent, etc.) to define relationships between sketch entities.
  - Understand and implement dimensioning and measurement practices based on ASTM standards.
  - Interpret and apply tolerance standards for various design scenarios.
  - Create 3D solid models using features like extrude, revolve, holes, fillets, chamfers, and ribs.
  - Utilize advanced modeling tools like sweep, loft, and thread features for complex geometries.
  - Effectively edit and modify existing features within a 3D model.
  - Assemble multiple components into a functional design, applying appropriate mate and assembly constraints.
  - Generate various types of engineering drawing views based on design models.
  - Apply and adhere to drawing standards for creating professional technical drawings.
  - Utilize the software's presentation module to create visuals and animations of designs.
  - Understand sheet metal design concepts and utilize specific features for creating sheet metal components.
  - Gain basic understanding of CAM principles, user interface, and setup processes for materials, cutting tools, and toolpath generation.
  - Identify different CAM functionalities for various manufacturing processes, including 2D drilling, milling (roughing and finishing), turning (facing, boring, etc.), wire cutting, routing, and multi-axis machining.
  - Comprehend the concept of process planning and identify different types of stock materials used in manufacturing.

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Syllabus

- **1. Introduction to 2D and 3D CAD**
  - 1.1 Modules
  - 1.2 Toolbars
  - 1.3 Units and Dimensions
  - 1.4 Important Terms and Definitions
- **2. 2D Sketch (ASTM Standards)**
  - 2.1 Sketch Environment
  - 2.2 Drawing Display Tools
  - 2.3 Sketching Entities
  - 2.4 Pattern
  - 2.5 Tolerance
  - 2.6 Work Feature
- **3. Dimension and Constraint (ASTM Standards)**
  - 3.1 Dimension
  - 3.2 Geometric Constraint
  - 3.2.1 Vertical Constraint
  - 3.2.2 Horizontal Constraint
  - 3.2.3 Perpendicular Constraint
  - 3.2.4 Tangent Constraint
  - 3.2.5 Concentric Constraint
  - 3.2.6 Coincident Constraint
  - 3.2.7 Concentric Constraint
  - 3.2.8 Symmetric Constraint
  - 3.2.9 Equal Constraint
  - 3.2.10 Parallel Constraint
  - 3.2.11 Collinear Constraint
  - 3.2.12 Smooth Constraint
  - 3.3 Measurement
- **4. Tolerances (ASTM Standards)**
  - 4.1 Parameter
  - 4.2 3D Sketching Entities
- **5. Solid Modelling**
  - 5.2 Modelling Tools
  - 5.2.1 Extrude Feature
  - 5.2.2 Revolve Feature
  - 5.2.3 Holes Feature
  - 5.2.4 Filet Feature
  - 5.2.5 Chamfer Feature
  - 5.2.6 Ribs Feature
  - 5.2.7 Thicken and Offset Feature

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- 5.3 Concept of Edit Feature
- 5.4 Advanced Modelling Tools
- 5.4.1 Sweep Feature
- 5.4.2 Lofted Feature
- 5.4.3 Coil Feature
- 5.4.4 Thread Feature
- 5.4.5 Shell Feature
- 5.4.6 Face Draft Feature
- 5.4.7 Replacing Face Feature
- 5.4.8 Boundary Patch Feature
- 5.4.9 Stitching Surfaces Feature
- 5.4.10 Sculpt Feature

- **6. Assembly Modelling**
  - 6.1 Types of Assembly
  - 6.2 Assembly Component
  - 6.2.1 Mate Constraint
  - 6.2.2 Angle Constraint
  - 6.2.3 Tangent Constraint
  - 6.2.4 Insert Constraint
  - 6.2.5 Rotation Constraint
  - 6.2.6 Rotation-Translation Constraint
  - 6.2.7 Transitional Constraint
  - 6.3 Edit Assembly Constraint
- **7. Drawing View**
  - 7.1 Types of Views
  - 7.2 Drawing Standards
  - 7.3 Drawing Sheets
  - 7.4 Dimension Style
  - 7.5 Parts Lists
- **8. Presentation Module**
  - 8.1 Presentation View
  - 8.2 Assembly Animation
- **9. Sheet Metal Components**
  - 9.1 Sheet Metal Components Parameter
  - 9.2 Sheets Metal Components
  - 9.2.1-Fold Feature
  - 9.2.2 Flange Feature
  - 9.2.3 Cut Feature
  - 9.2.4 Corner Seam Feature
  - 9.2.5 Bend Feature

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- 9.2.6 Corner Round Feature
- 9.2.7 Corner Chamfer Feature
- 9.2.8 Hem Feature
- 9.2.9 Contour Flange Feature

- **10. CAM**
  - 10.1 Introduction of CAM
  - 10.1.1 User Interface
  - 10.1.2 Setup of materials
  - 10.1.3 Setup of cutting tools
  - 10.1.4 Strategy of cutting processes
  - 10.1.5 Generating tool paths
  - 10.1.6 Tool parts simulation
  - 10.2 2D CAM
  - 10.2.1 Holes Drilling
  - 10.2.2 Face cutting
  - 10.2.3 Side cutting
  - 10.2.4 Pocket cutting
  - 10.2.5 Slot cutting
  - 10.3 CAM Milling
  - 10.3.1 Rough cutting
    - 10.3.1.1 Z level Roughing
    - 10.3.1.2 Parallel Roughing
    - 10.3.1.3 Plunge Roughing
    - 10.3.1.4 Flat Roughing
    - 10.3.1.5 Cutting Boundaries
    - 10.3.1.6 Step over and leads
  - 10.3.2 Finish cutting
    - 10.3.2.1 Parallel Finishing
    - 10.3.2.2 Z Level Finishing
    - 10.3.2.3 Corner and Pencil Finishing
    - 10.3.2.4 Iso line Finishing
    - 10.3.2.5 Radial and Spiral Finishing
    - 10.3.2.6 Flow line Finishing
    - 10.3.2.7 Between 2 curves Finishing
    - 10.3.2.8 Swarf Finishing
    - 10.3.2.9 Cutting Finishing
    - 10.3.2.10 Step overs Finishing
  - 10.4 CAM Lathe
  - 10.4.1 Facing
  - 10.4.2 Boring

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- 10.4.3 Grooving
- 10.4.4 Threading (Inside and Outside)
- 10.4.5 Cut off
- 10.5 CAM Wire Cut
- 10.5.1 Die Cutting
- 10.5.2 Punch Cutting
- 10.5.3 Taper Cutting
- 10.5.4 4 Axis Wiring Cutting
- 10.5.5 No Core Cutting
- 10.6 CAM Router
- 10.6.1 Contouring
- 10.6.2 Pocketing
- 10.6.3 Engraving
- 10.6.4 Chamfering
- 10.6.5 Raster to vector Translator
- 10.6.6 Nesting
- 10.7 CAM Multi-Axis
- 10.7.1 4 Axis Milling
- 10.7.2 5 Axis Swarf Milling
- 10.7.3 5 Axis Index Drilling

- **11. Process Planning**
  - 11.1 Introduction
  - 11.2 Stocks and Types of Stocks
  - 11.3 Squaring Graphs
  - 11.4 Feature Interaction Graphs

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Course Unit Requirements

Prerequisite Course Unit

- MT06

CAD Software

- PTC Creo Parametric
- SolidWorks

Computing device with internet connectivity

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