AutoCAD, Catia, Ansys-Curriculum

1.Introduction to Catia

1.1 **Computer Aided Software that Involves creating 2D sketches, applying constraints, and building 3D models for design and engineering**

2.Basics Of Catia

2.1 **Catia Working Module**

- Sketcher
- Part Design
- Assembly Design
- Surface Design
- Generative Drafting

2.2 **Catia V5 Interface**

- File Toolbar
- Menu Bar
- Application Toolbar
- View Toolbar

2.3 **Applications of Catia**

- Furniture
- Construction
- Aerospace
- Automotive

3.Sketchers

3.1 **Sketcher Interface**

3.2 **Coordinate System**

3.3 **Profile Tool Bar**

3.4 **Operations Toolbar**

3.5 **Constraints**

Part Modeling

4.1 **Pads, Drafted Pad, Multi-Pad**

4.2 **Pockets, Shafts, Groove, Hole**

4.3 **Rib, Slot, Solid Combine, Stiffener, Multi Section Solid**

4.4 **Dress-up Features, Edge Fillet, Tritangent Fillet, Draft Angle,**

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5.Assembly Modeling

5.1 **Wheel Support Assembly**

5.2 **Shaft Angle**

5.3 **Fixed Component**

6.Ansys Introduction

6.1 **Introduction**

ANSYS software is a powerful simulation tool for engineering analysis, including structural, thermal, and fluid dynamics.

6.2 **Finite Element Method**

Numerical technique used to analyse and solve complex structural, thermal, and fluid problems.

6.3 **Application of FEM**

Structural & Solid Mechanics: Used to evaluate stress, strain, and deformation in engineering structures like bridges and buildings.

Thermal analysis: Simulates heat distribution and thermal behaviour in materials and systems.

Fluid dynamics: Helps model fluid flow, pressure distribution, and related phenomena.

Automotive and Aerospace: Analyses vehicle components for safety, durability, and aerodynamic performance.

6.4 **Ansys Interface**

- Working with Cells
- Menu Bar

7.Truss Problem

7.1 **Learning Outcomes**

- Generate line sketches and define new material properties in ANSYS Workbench
- Perform Static Structural Analysis on Trusses using Ansys Workbench

7.2 **Problem Description**

- Truss bridges can span long distances and support heavy weights without intermediate supports.
- They are economical to construct and are available in a wide variety of styles
- Consider the following Planar Truss, constructed of wooden timbers, which can be used in parallel to form bridges.
- Determine the deflections at each joint of the truss under the given loading conditions.

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8.Frame Analysis

8.1 Learning Outcomes

- Model the Frame
- Apply Pressure Loads
- Determine the Deformation and Stresses

8.2 Problem Description

- Steel Framing systems provide cost-effective solutions for low rise buildings.
- They have high Strength-To-Weight Ratios and can be prefabricated and custom designed.
- Consider the following two-storey building constructed with structural steel I-Beams
- Determine the deformations and the stresses in the frame when a uniform load of 50kN/m is applied on the second floor of the building.

9.Chassis Analysis

9.1 Structural integrity

Analyses the chassis to evaluate stress distribution, strength, and deformation under various loading conditions.

9.2 Vibration and fatigue

Assesses the chassis' response to vibrations and fatigue to ensure durability and longevity.

9.3 Crashworthiness

Simulates impact scenarios to evaluate the chassis' ability to absorb energy and protect occupants during collisions.

9.4 Optimization

Improves weight, material selection, and geometry for enhanced performance, fuel efficiency, and safety.

10.AutoCAD Interface & Basics

10.1 Introduction

CAD software: AutoCAD is a leading computer-aided design (CAD) software used for creating precise 2D and 3D drawings in engineering, architecture, and design.
Versatile design tool: It supports a wide range of design applications, from drafting floor plans to creating mechanical parts and electrical schematics.
Industry standard: Known for its accuracy, efficiency, and compatibility, AutoCAD is widely used across multiple industries for professional drafting and documentation.

Customizable features: AutoCAD offers customizable toolsets, automation features, and supports scripting to enhance productivity.

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10.2 Career Oriented

Mechanical Drafters: Prepares Plans for Machinery and Mechanical Devices

Architectural Drafters: Creates detailed technical drawings and plans based on architects' designs, used for residential and commercial buildings construction and permits.

Civil Drafters: Prepares detailed drawings and topographical maps for civil engineering projects like highways, bridges, and creates precise layouts, grading plans, and site drawings based on engineers' designs and specifications.

Electrical Drafters: Prepares diagrams of Wiring Electrical System Layout based on Electricians specifications

Interior Drafters: drafters create detailed technical drawings for interior spaces, including layouts for furniture, fixtures, and finishes based on designers' concepts.

10.3 AutoCAD Interface

- Menu Browser, Quick Access Toolbar, Menu Bar, Tab Ribbon
- Command Line, Cursor, User Interface Area
- Panel Toolbar, Navigator Box, Statusbar, Panel

11.Draw commands

11.1 Line

Creates straight lines between two points, essential for constructing precise 2D shapes and layouts.\

11.2 Circle

Draws circles by specifying the centre point and radius, useful for creating round objects or details.

11.3 Polyline

Generates connected line segments or arcs as a single object, allowing for easier editing and manipulation
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11.4 Rectangle

Quickly creates rectangular shapes by specifying opposite corners, often used in floor plans and structural layouts.

12.Modify commands

12.1 Move

Relocates selected objects to a new position by specifying a base point and a destination point, making adjustments easier.

12.2 Trim

Removes excess parts of objects by defining cutting edges, helping to clean up intersecting lines and shapes.

12.3 Offset

Creates parallel lines or curves at a specified distance from the original, useful for creating walls or contours.

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12.4 **Mirror**
Duplicates objects by flipping them across a defined axis, maintaining symmetry in designs without re-drawing.

13. Annotate Dimension Style Manager

13.1 **Dimension customization**
The Dimension Style Manager allows users to create and manage custom dimension styles, adjusting text, lines, and symbols to meet specific project requirements.

13.2 **Precision control**
Users can set precise formatting for units, tolerances, and scale factors, ensuring accurate representation of measurements in drawings.

13.3 **Style consistency**
Ensures uniformity across all dimensions in a project by applying consistent styles to various drawing elements.

13.4 **Multiple style options**
Supports multiple dimension styles for different drawing contexts, such as architectural, mechanical, or civil projects.

14. Layers & Blocks

14.1 **Layers**
Organise drawing elements by assigning them to different layers, allowing control over visibility, colour, line type, and editing for improved workflow.

14.2 **Blocks**
Reusable collections of objects grouped together as a single entity, enabling efficient repetition and consistency of standard elements like doors, windows, or furniture.
Layer management

14.3 **Layer Management**
Layers help separate design components (e.g., electrical, plumbing) for easier editing and visualisation without altering the entire drawing.
Block libraries

14.4 **Block libraries**
AutoCAD allows users to create block libraries, making it easier to standardise and quickly insert common design elements across multiple projects.

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15.Isometric Views

15.1 3D-like representation
Isometric views in AutoCAD provide a pseudo-3D perspective of 2D drawings, where all axes are drawn at equal angles, offering a clearer spatial understanding.

15.2 Easy switching
Users can quickly switch between isometric planes (top, right, left) to draw at different angles and align components accurately.

15.3 Isometric Grid
AutoCAD provides an isometric grid to aid in drawing accurate angles and shapes, ensuring alignment and precision.

15.4 Useful for technical drawings
Commonly used in technical and engineering drawings to visually represent complex parts, assemblies, or layouts in 3D-like form without full 3D modeling.

16. Modeling Commands

16.1 Extrude
Converts 2D shapes into 3D objects by extending them along a specified axis, commonly used for creating solid models from profiles.

16.2 Revolve
Creates 3D solids or surfaces by rotating a 2D shape around an axis, useful for cylindrical or symmetrical objects.

16.3 Loft
Generates complex 3D shapes by connecting multiple cross-sectional profiles, ideal for organic or non-linear designs.

16.4 Sweep
Constructs 3D objects by moving a 2D profile along a specified path, enabling the creation of pipes, rails, or similar shapes.

17.Generating 3D Diagrams

17.1 3D viewports
AutoCAD offers multiple viewports for visualising 3D models from different angles, ensuring precise design adjustments.

17.2 Shading and rendering
Apply shading, materials, and rendering techniques to enhance the realism of 3D diagrams, giving a clearer representation of the final product.

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18.Solid Editing Tools

18.1 **Fillet**
Rounds the edges or corners of 3D solids, enhancing the aesthetics and functionality of designs by softening sharp edges.

18.2 **Chamfer**
Creates beveled edges by trimming corners of 3D solids, useful for reducing sharpness and easing manufacturing processes.

18.3 **Shell**
Converts a solid into a hollow object by removing faces and defining wall thickness, often used for manufacturing or casting simulations.

18.4 **Boolean operations**
Tools like Union, Subtract, and Intersect combine or modify solids by merging, cutting, or finding overlapping volumes, enabling complex shapes to be created easily.

19.Exercises

19.1 **Modeling A Screw Jack**
Involves creating a 3D model of its key components, such as the base, threaded screw, nut, and lifting platform.

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CAPSTONE PROJECTS

1 **Static Structural Analysis of Spur Gear using ANSYS for Different Loads**

- Model the spur gear shaft using CATIA tools like Sketch, shaft etc.
- Select the materials for the spur gear.
- Perform the structural Analysis using ANSYS and determine the stress and deformation.
- Compare the results and find the best material for the Spur Gear.

2 **Modeling of Oldhams Coupling using AutoCAD 3D**

- Begin by modeling the two base disks in AutoCAD 3D, defining the dimensions and adding central holes to accommodate the shafts, ensuring precise alignment for effective coupling.
- Create the middle sliding piece, which transfers torque between the two disks, including the slots that allow lateral movement to accommodate misalignment in the shafts.
- Assemble the two disks and the sliding piece within the 3D model, positioning them to replicate the actual function of Oldham's coupling and verifying the correct fit.
- Add details such as keyways, locking screws, and any necessary constraints to ensure the coupling holds together under rotation, allowing for realistic movement and rotation during simulation.

3 **Modeling of stuffing box using CATIA**

- Begin by defining the key dimensions and specifications of the stuffing box, including the inner diameter, outer diameter, and depth, to ensure proper fit and functionality in the intended application.
- Use CATIA's Part Design workbench to create the 3D model of the stuffing box, starting with a cylindrical base and incorporating features like grooves for packing material and mounting points for bolts.
- Model additional components such as the gland follower and packing rings, ensuring all parts align correctly and interact seamlessly within the assembly for effective sealing.
- Utilize CATIA's analysis tools to simulate the stuffing box's performance under various operational conditions, assessing factors such as pressure and material stress to validate the design before production.

LIVE PROJECT

1 **Static Structural Analysis of Conventional Sugar Mill Roller Shaft**

- Model the Sugar Cane Roller Mill shaft in the ANSYS Geometric Modeler.
- Select the materials for the Sugar Cane Roller Mill shaft.
- Perform the structural Analysis using ANSYS and determine the stress and deformation.
- Compare the results and find the best material for the Sugar Cane Roller Mill shaft.

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