

# *Automation (21-541)*

*Advanced Manufacturing Laboratory  
Department of Industrial Engineering  
Sharif University of Technology*

*Session # 9*

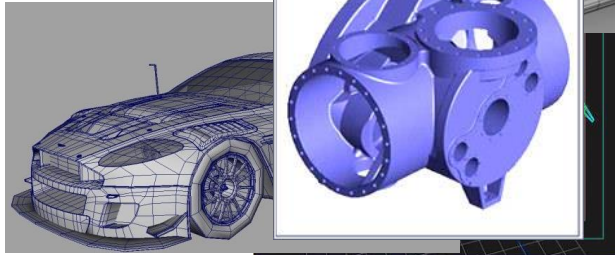


## *Session Schedule*

- *Computer-Aided Design (CAD)*
  - *Geometric modeling*
    - *Geometric modeling techniques*
    - *Geometric data exchange*

## Computer-Aided Design (CAD)

- **Geometric modeling :**
  - *Computer representation of the geometry of a component using software is called a geometric model.*
  
- *Geometric modeling is done in three principal ways:*
  - *Wire frame modeling*
  - *Surface modeling*
  - *Solid modeling*



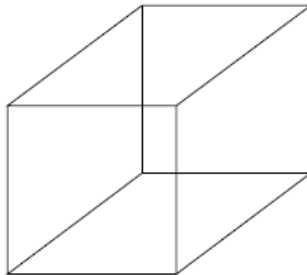
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## Computer-Aided Design (CAD)

- **Geometric modeling :**
  - **Wire frame modeling**
    - *In wire frame modeling the object is represented by its edges.*
    - *In the initial stages of CAD, wire frame models were in 2-D. Subsequently 3-D wire frame modeling software was introduced.*



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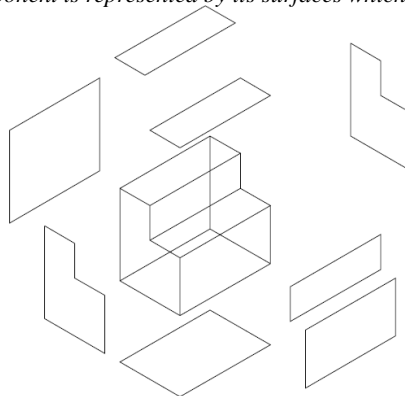
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## Computer-Aided Design (CAD)

### ▪ Geometric modeling :

#### ▪ Surface modeling

- In this approach, a component is represented by its surfaces which in turn are represented by their vertices and edges.



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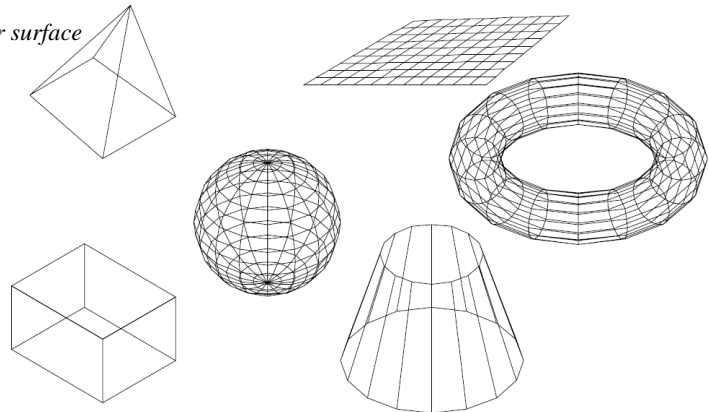
## Computer-Aided Design (CAD)

### ▪ Geometric modeling :

#### ▪ Surface modeling

- Standard surface types available for surface modeling:

- box,
- pyramid,
- wedge,
- dome,
- sphere,
- cone,
- torus,
- dish
- and mesh



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## Homework # 6

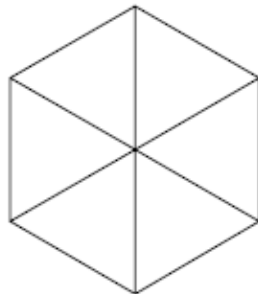
- *Extend the simple program of HW4 for interpreting simple following objects. You should use your CIM data base structure to maintain the geometric data.*
  - *A simple interface can be applied to plot a cub and a sphere.*
  
- *The HW should be sent to [omidf@ie.sharif.edu](mailto:omidf@ie.sharif.edu) till Saturday, 25<sup>th</sup> of Aban (Nov, 16<sup>th</sup> ,2013)*
- *Email subject: “HW6:GroupCode”*

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## Computer-Aided Design (CAD)

- *Geometric modeling :*
  - *Solid modeling*
    - *The representation of solid models uses the fundamental idea that a physical object divides the 3-D Euclidean space into two regions, one exterior and one interior; separated by the boundary of the solid.*

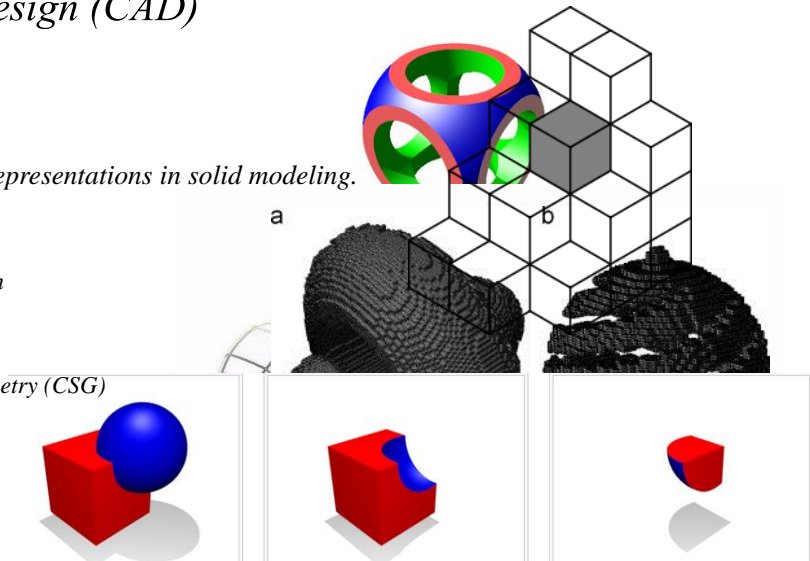


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## Computer-Aided Design (CAD)

- **Geometric modeling :**
  - Solid modeling
  - There are six common representations in solid modeling.
    - Spatial Enumeration
    - Cell Decomposition
    - Boundary Representation
    - Sweep Methods
    - Primitive Instancing
    - Constructive Solid Geometry (CSG)

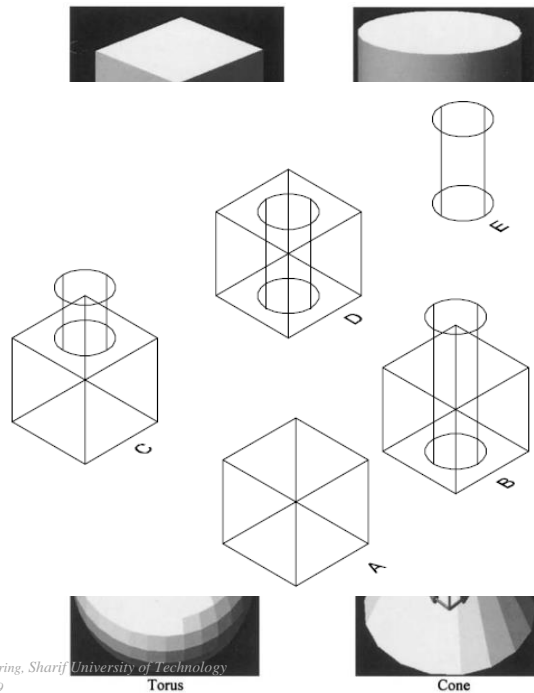


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## Computer-Aided Design (CAD)

- **Geometric modeling :**
  - Solid modeling
    - Constructive Solid Geometry (CSG)
    - In a CSG model, physical objects are created by combining basic elementary shapes known as primitives like blocks, cylinders, cones, pyramids and spheres.
  - The Boolean operations like union ( $\cup$ ), difference ( $-$ ) and intersection  $\cap$  are used to carry out this task.



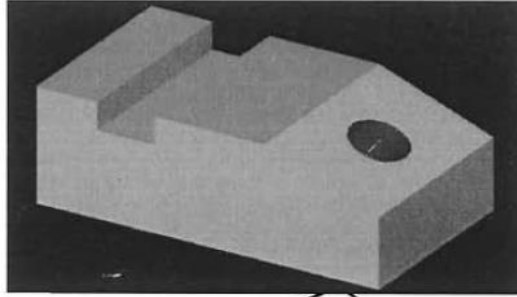
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Torus

Cone

## Homework # 7

- Consider the following solid model. Use the CSG method and draw the CSG tree model based on the CSG primitive objects and operators.



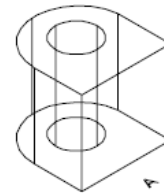
- The HW should be sent to [omidf@ie.sharif.edu](mailto:omidf@ie.sharif.edu) till Saturday, 2<sup>nd</sup> of Azar (Nov, 23<sup>rd</sup>, 2013)
- Email subject: "HW7:Student Number"

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## Computer-Aided Design (CAD)

- Geometric modeling :
  - Solid modeling
    - Boundary Representation (B-rep)
    - Boundary representation is built on the concept that a physical object is enclosed by a set of faces which themselves are closed and oriented surfaces.
  - Geometric entities -- Topological entities
  - Point -- Vertex
  - Curve, line -- Edge
  - Surface -- Face



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## Computer-Aided Design (CAD)

- *Geometric modeling :*
  - *Solid modeling*
    - *Solid models differ from wire frame and surface models in the kind of geometric information they provide.*
    - *Wire frame models only show the edge geometry of an object. They say nothing about what is inside an object.*
    - *Surface models provide surface information, but they too lack information about an object's internal structure. Solid models provide complete geometric descriptions of objects.*

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## Computer-Aided Design (CAD)

- *Geometric modeling :*
  - *Solid modeling*
    - *Solid models can be used for quick and reliable design analysis.*
    - *Solid models apart from geometric information provide important data such as volume, mass, mass properties and center of gravity.*
    - *The designer can also export models created to other applications like*
      - *finite element analysis (FEA),*
      - *rapid prototyping and other special engineering applications*

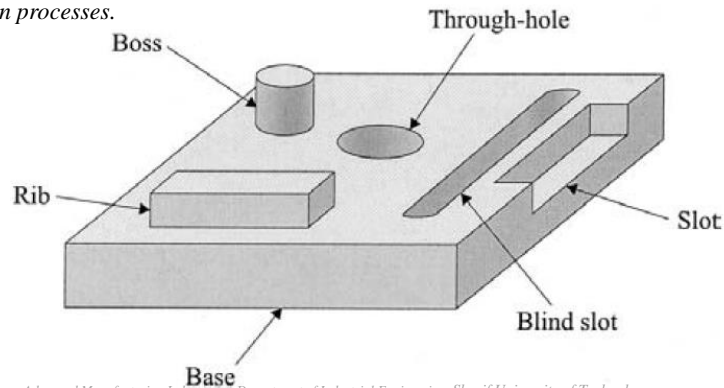
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## Computer-Aided Design (CAD)

- *Geometric modeling :*

- *Feature-Based Design*

- *Features can be seen as specific geometric shapes on a part that can be associated with certain fabrication processes.*



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## Computer-Aided Design (CAD)

- *Geometric modeling :*

- *Feature-Based Design*

- *Features have been commonly classified as*

- *Form,*
      - *Material,*
      - *Precision,*
      - *and technological features.*

- *It has been long advocated that if these features were highlighted during the modeling phase of a product's design process, in the subsequent*

*production-planning phases, engineers could take advantage of this information in accessing historical data regarding the production of these features.*

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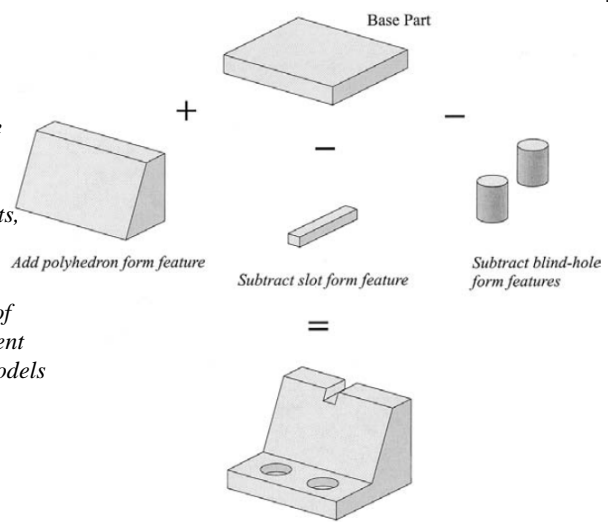
## Computer-Aided Design (CAD)

- *Geometric modeling :*
  - *Feature-Based Design*
    - *The objective of design by features is :*
      - *To increase the efficiency of the designer during the geometric-modeling phase*
      - *To provide a bridge (mapping) to engineering-analysis and process-planning phases of product development.*

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## Computer-Aided Design (CAD)

- *Geometric modeling :*
  - *Feature-Based Design*
    - *In feature-based design, parts' solid models are configured through a sequence of form-feature attachments (subtractions and additions) to the primary (base stock) representations of the parts, which can be as simple as a rectangular box.*
    - *These features could be chosen from a library of predefined (and sometimes application dependent features or could be extracted from the solid models of earlier designs.*



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