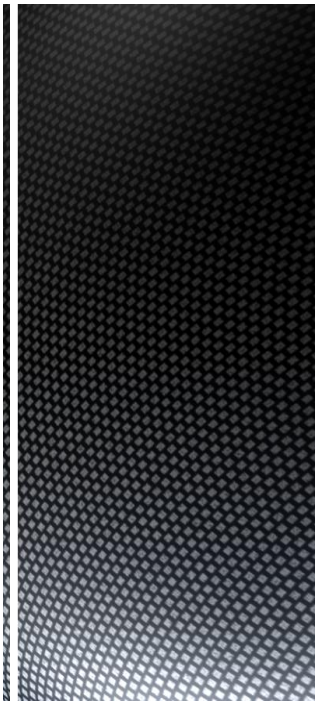


# *CAD/CAM (21-342)*

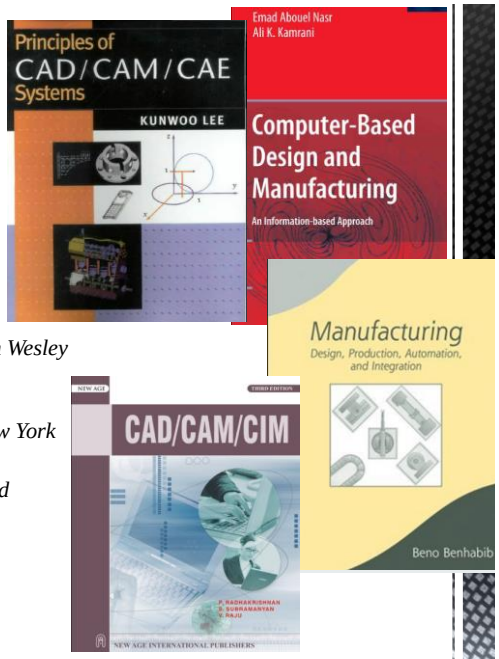
*Advanced Manufacturing Laboratory*
*Department of Industrial Engineering*
*Sharif University of Technology*

*Session # 5*

## *Course Description*

- *Instructor*
  - *Omid Fatahi Valilai, Ph.D. Industrial Engineering Department, Sharif University of Technology*
  - *Email: FValilai@sharif.edu , Tel: 6616-5706*
  - *Website: Sharif.edu/~fvalilai*
- *Class time*
  - *Saturday- Monday* *10:30-12:00*
- *Course evaluation*
  - *Mid-term* *(25%)*
  - *Final exam* *(40%)*
  - *Quiz* *(5%)*
  - *Exercise* *(30%)*

# Course Description *(Continued ...)*




- *Mid-term session:*
  - *Monday: 8th Ordibehesht 1393, 10:30 ~ 12:30*
- *Final Exam:*
  - *Saturday: 24th Khordad 1393, 15:00 ~ 17:30*
- *Reference:*
  - *Lee, Kunwoo; "Principles of CAD/CAM/CAE systems", 1999, Addsion Wesley*
  - *Abouel Nasr, Emad; Kamrani, Ali K.; "Computer-Based Design and Manufacturing: An Information-Based Approach", 2007, Springer, New York*
  - *Benhabib, Beno; "Manufacturing: Design, Production, CAD/CAM, and Integration", 2003, Marcel Dekker Inc, New York*
  - *Radhakrishnan, P.; Subramanian, S.; Raju, V.; "CAD/CAM/CIM", 3rd edition, 2005, New age international (P) limited publishers, New York*



# Course Description *(Continued..)*

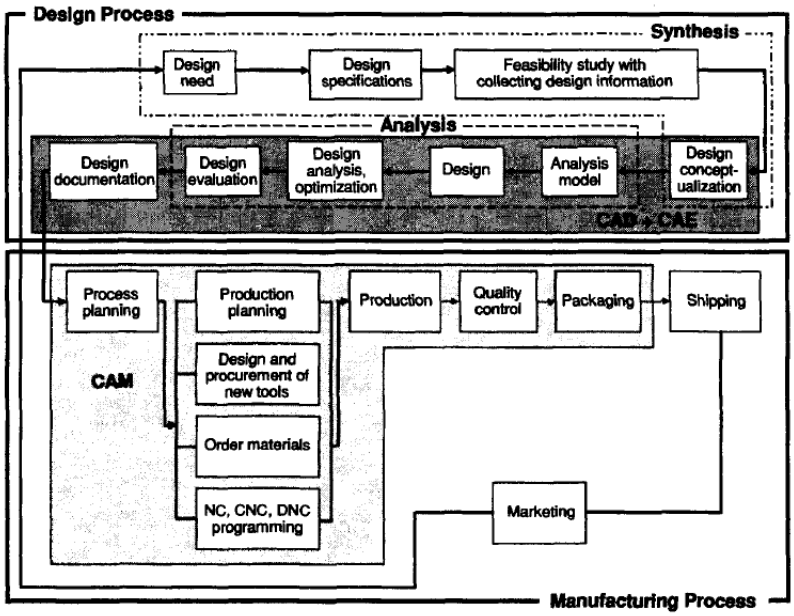
- *Contents:*
  - *Introduction to CAD/CAM/CAE systems* *(5 sessions)*
  - *Components of CAD/CAM/CAE systems* *(2 sessions)*
  - *Geometric modeling systems* *(3 sessions)*
  - *Optimization in CAD* *(5 sessions)*
  - *Rapid prototyping and manufacturing* *(3 sessions)*
  - *Virtual engineering* *(2 sessions)*
  - *Product Life Cycle Cost Model* *(2 sessions)*
  - *Computer-Based Design and Features/Methodologies of Feature Representations* *(5 sessions)*
  - *Feature-Based Process Planning and Techniques* *(3 sessions)*
  - *Collaborative Engineering* *(2 sessions)*

# *Course Description* *(Continued..)*

- *Contents:*
  - *Geometric modeling systems* *(3 sessions)*
    - *Wireframe modeling systems*
    - *Surface modeling systems*
    - *Solid modeling systems*
    - *Non-manifold modeling systems*
    - *Assembly modeling systems*

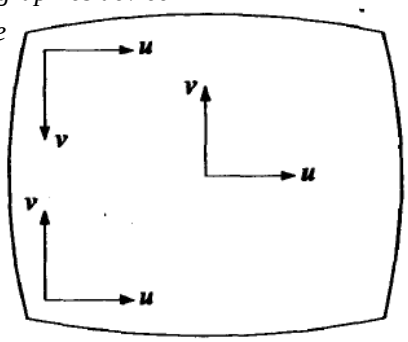


# *Introduction to CAD/CAM/CAE systems*



# Geometric modeling systems

- *Basic concepts of a graphic programming system*
  - *Coordinate systems*
    - *Two basic tasks required to display an image of an object on a graphics device*
      - *Specifying the location of all the points on the object in space*
      - *Determining which locations on the display*
    - *Device coordinate system*
    - *Virtual device coordinate system*






# Geometric modeling systems

- *Graphic primitives:*
  - *Transformations*
    - *Scaling*

$$\begin{bmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

    - *Translation*

$$\begin{bmatrix} 1 & 0 & 0 & -T_x \\ 0 & 1 & 0 & -T_y \\ 0 & 0 & 1 & -T_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

    - *Rotation*

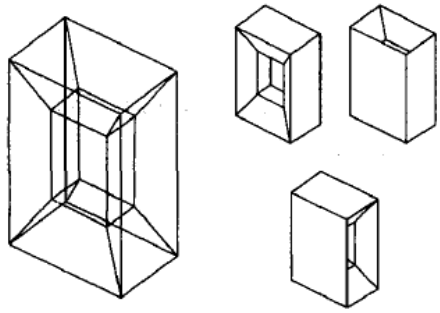
$$R_z = \begin{bmatrix} Cos\theta & Sin\theta & 0 & 0 \\ -Sin\theta & Cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_x = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & Cos\phi & Sin\phi & 0 \\ 0 & -Sin\phi & Cos\phi & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_y = \begin{bmatrix} Cos\varphi & 0 & -Sin\varphi & 0 \\ 0 & 1 & 0 & 0 \\ Sin\varphi & 0 & Cos\varphi & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

# *Geometric modeling systems*

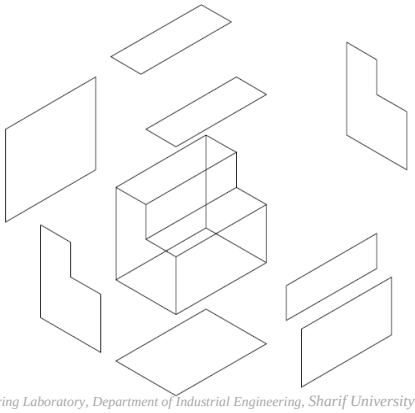
- *Wireframe modeling systems*
  - *This system represent a shape by its characteristics lines and end points.*
  - *The system uses lines and points to display three-dimensional shapes and allow manipulation of the shapes by modifying the lines and points.*





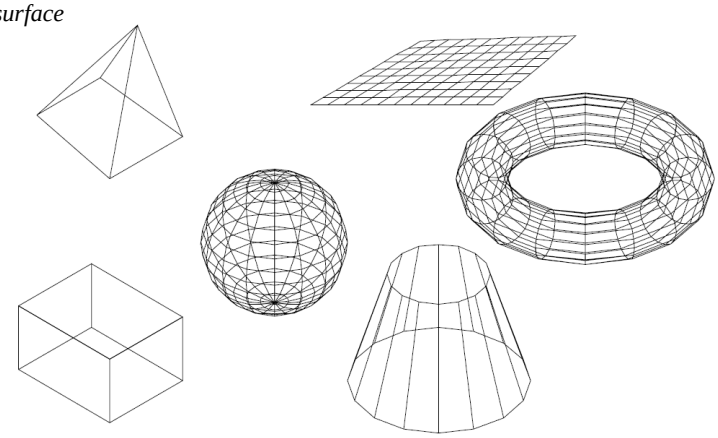
# *Geometric modeling systems*

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



# *Geometric modeling systems*

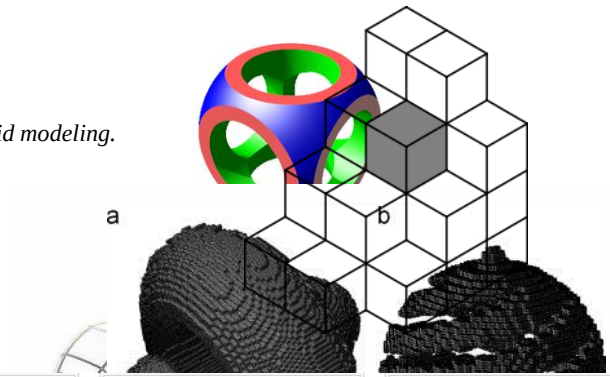
- *Surface modeling*
  - *Standard surface types available for surface modeling:*
    - *box,*
    - *pyramid,*
    - *wedge,*
    - *dome,*
    - *sphere,*
    - *cone,*
    - *torus,*
    - *dish*
    - *and mesh*

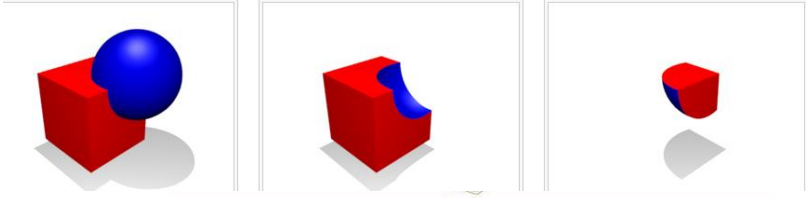




# *Geometric modeling systems*

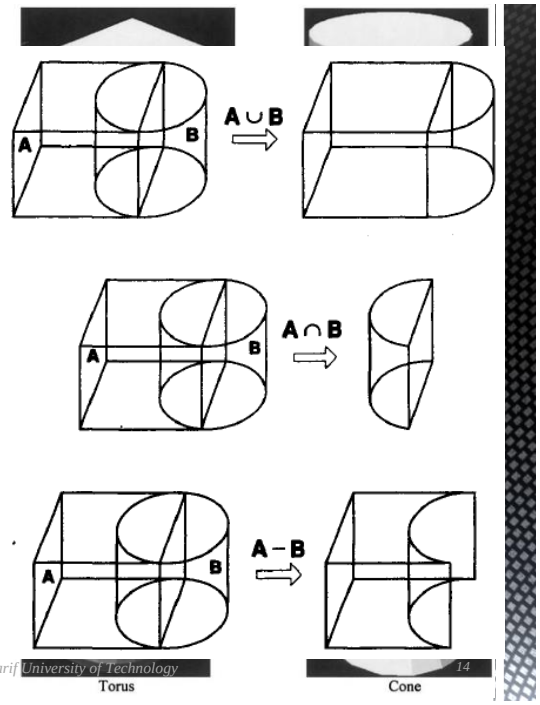
- *Solid modeling*
  - *There are six common representations in solid modeling.*
    - *Spatial Enumeration*
    - *Cell Decomposition*
    - *Boundary Representation*
    - *Sweep Methods*
    - *Primitive Instancing*
    - *Constructive Solid Geometry (CSG)*



# Geometric modeling systems

- *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 (∪), difference (–) and intersection ∩ are used to carry out this task.*



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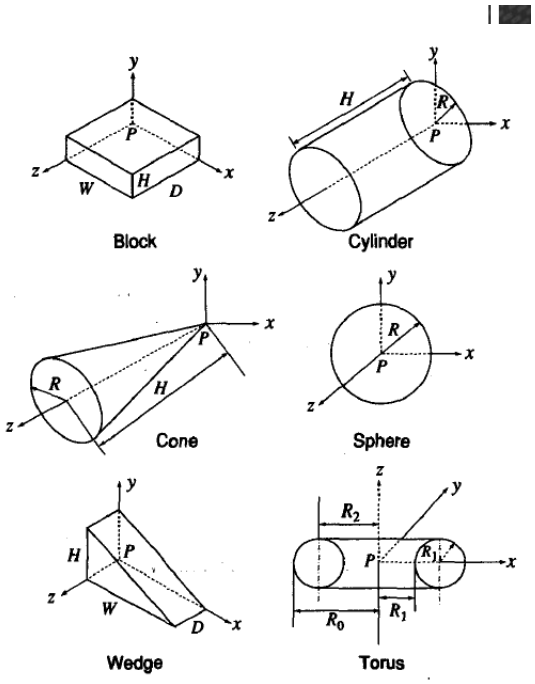
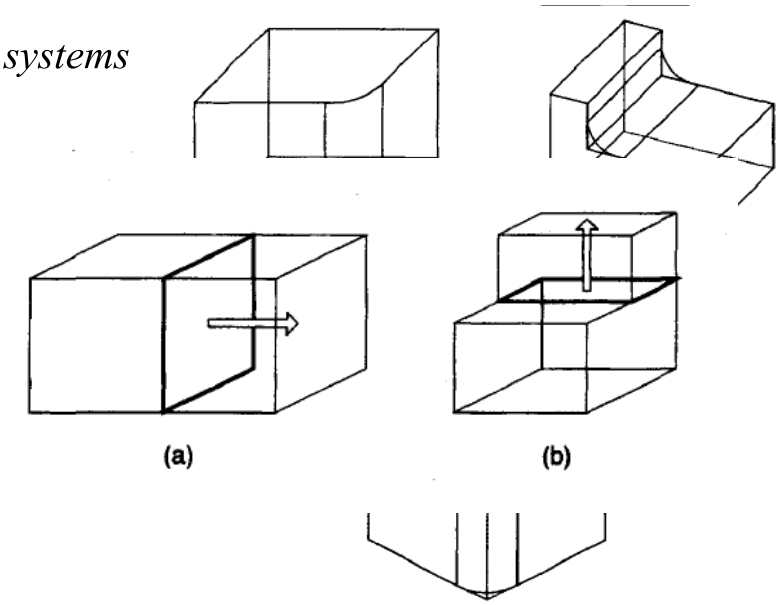


# *Geometric modeling systems*

- *Solid modeling*
  - *Operations*
    - *Boolean operations*
    - *Sweeping*
    - *Skinning*
    - *Rounding*
    - *Lifting*

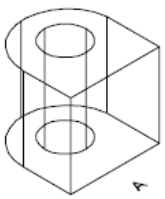





# *Geometric modeling systems*

- *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* |



## *Geometric modeling systems*

- *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.*



## *Geometric modeling systems*

- *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*