LECTURE # 4

CAD/CAM COURSE

TOPIC OF DISCUSSION

GEOMETRIC MODELING

WHAT IS A GEOMETRIC MODEL

- CAD attempts to eliminate the need of developing a prototype for testing and optimizing the design
- CAD evaluates a design using a model with geometric parameters created on computer
- Such a model is called Geometric Model
- Various types of analysis can be done interactively on this virtual model using different application software

NEED OF A GEO MODEL

- In a traditional product design cycle, a concept of designer's mind travels to the manufacturing engineer to produce a part
- However this essentially become a multi-stage process where task of manufacuring engineers starts when designer work is over
- But in a typical CAD/CAM environment, a virtual model which is called Geometric Model is to be analysed by all the departments during product design cycle & modified according to their predefined rights

NEED OF A GEO MODEL

- Designers generate detailed specifications for the parts and assemblies to be produced
- These specifications consist primarily of geometrical information about the parts/ assemblies
- The proposed models/ designs are analyzed for compliance with the specifications under simulated conditions, and are modified if necessary
- This is done by Computer aided optimization technique
- These analyzed models with part specifications are passed on to manufacturing, where decisions are made about the processes to be used
- All the processes along the product development cycle use the geometrical model's information, generated in the modeling or design stage

USES OF GEOMETRIC MODEL

- ***Modeling or Design (CAD)***
  - Model must be easy to generate
  - Facilitate minimum calculations at the user level
  - Encompass different options of generating the model with advanced and easy modifying tools and techniques
  - Better graphics to visualize the design graphically

USES OF GEOMETRIC MODEL

- ***Analysis & Optimization (CAE)***

  - Mass property calculation
  - Volumetric/area calculations
  - Stress Analysis/ CFD Analysis
  - Assembly mating
  - Motion analysis of mechanisms
  - Tolerance check analysis

USES OF GEOMETRIC MODEL

- ***Computer Aided Desing & Drafting (CADD)***
  - Generating production drawings
  - Visualizing information and drawings
    - Using hidden lines
    - Hatched or shaded images
  - Generating the dimensions, production symbol and etc.

USES OF GEOMETRIC MODEL

- ***Computer Aided Manufacturing (CAM)***
  - Process planning & scheduling
  - Part programming
  - Robot programming
  - Actual production control

USES OF GEOMETRIC MODEL

- ***Bill of Material (BOM) Generation***
  - Material requirement
- ***Inspection & Quality Control***
  - Inspection machines/ robot inspection
  - Comparison of design and part specification

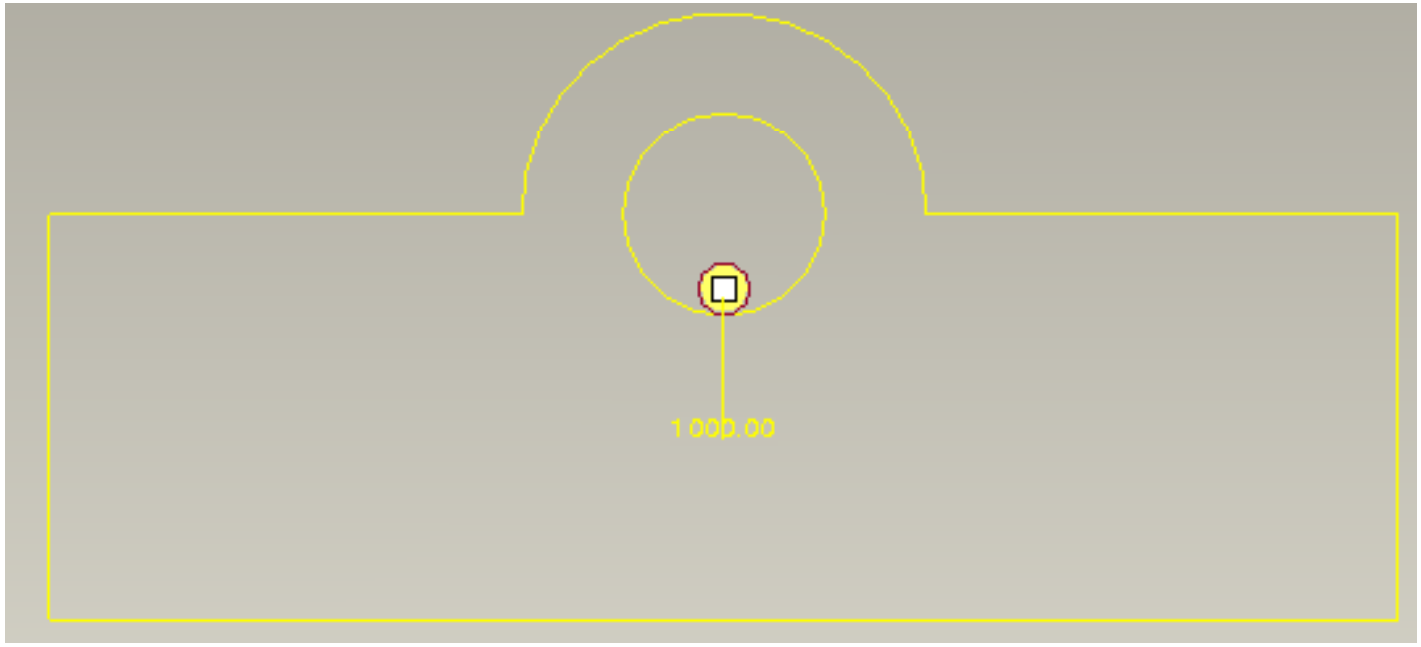
TYPES OF GEOMETRIC MODEL

- Basically geometric models can be broadly classified into following three types based on its coordinates
  - ❖ Two Dimensional Model
  - ❖ 2 ½ Dimensional Model
  - ❖ 3 Dimensional Model

TYPES OF GEOMETRIC MODEL

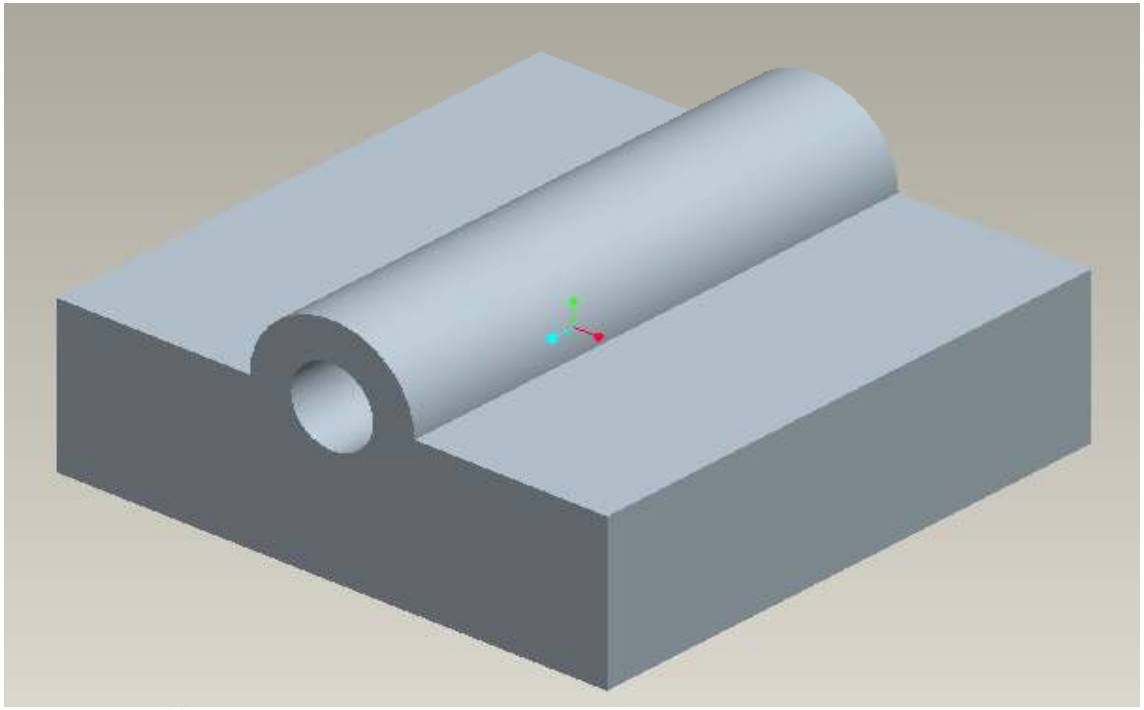
- ***2 Dimensional Model***

  Two dimensional Model is basically a model which is made in typical 2D coordinates



TYPES OF GEOMETRIC MODEL

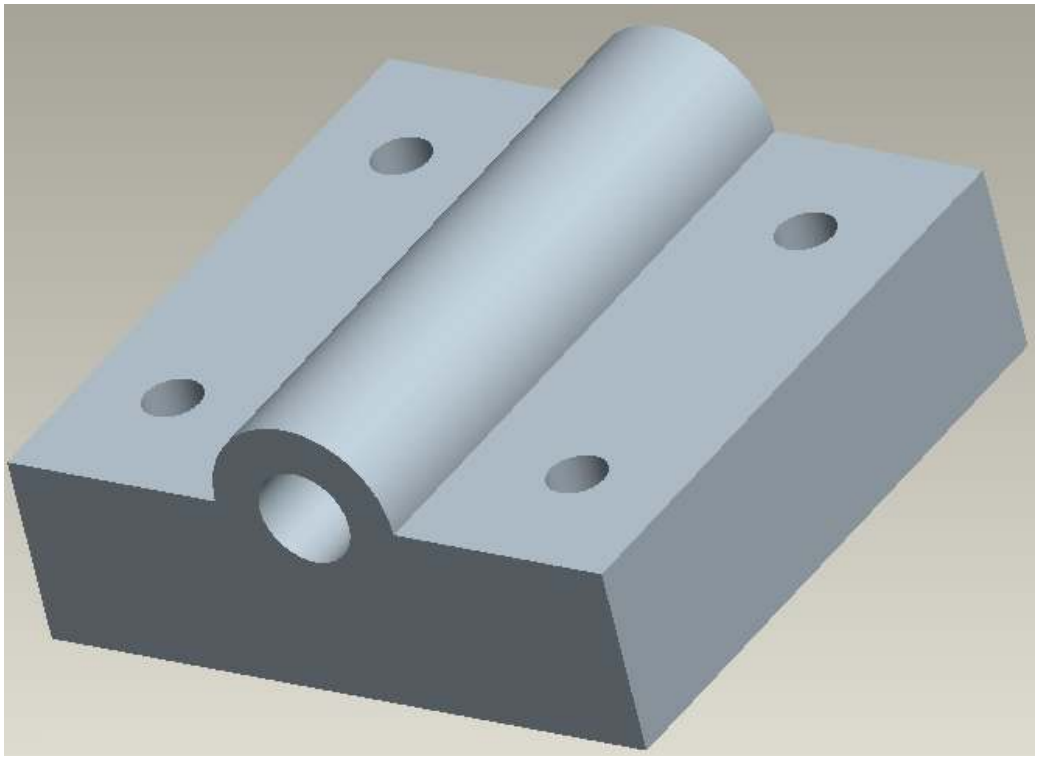
- ***2 ½ Dimensional Model***
  - 2 ½ dimensional model is 1 step a head than 2D model
  - It is basically a 2D model with an extruded depth without any detail



TYPES OF GEOMETRIC MODEL

- ***3 Dimensional Model***

  3D models are those models which have detailed features on its depth



REPRESENTATION OF 3D MODEL

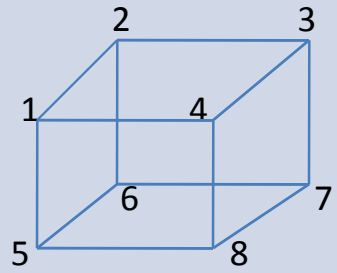
- Three are basically three distinct ways of representing a 3D model

  - Wire Frame Model
  - Surface Model
  - Solid Modeling

REPRESENTATION OF 3D MODEL

- ***Wire Frame Model***
  - Wire frame models are created using basic entities with their attributes
  - These entities are basic building blocks and attributes defines the properties of the entities required to completely define that entity
  - The entities that are combined to generate the model can be catagorized as analytical curves like lines, cricle, ellipse, hyperbola, parabola etc.

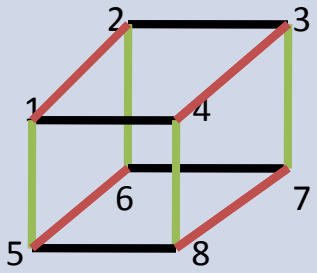
REPRESENTATION OF 3D MODEL

Wire Frame Model	Basic Entities	Edge Type
	*8 Vertices* (1, 2, 3, 4, 5, 6, 7, 8) *12 Edges* (1-2, 2-3, 3-4, 4-1, 1-5, 2-6, 3-7, 4-8, 5-6, 6-7, 7-8, 8-5)	12 Linear Edges

REPRESENTATION OF 3D MODEL

- ***Surface Models***
  - Surface models are also created either by using analytical methods (plane surface, ruled surface, surface of revolution and tabulated cyclinder etc.) or the sythetic surfaces (Bicubic, B-Spline, Coons patch and Gordon surface).
  - Same cube may be represented as a surface model with 06 faces instead of 12 edges

REPRESENTATION OF 3D MODEL

Wire Frame Model	Basic Entities	Face Type
	*8 Vertices* (1, 2, 3, 4, 5, 6, 7, 8) 06 Faces	6 Plane Surfaces

REPRESENTATION OF 3D MODEL

- ***Solid Modeling***
  - Reprentations helps to create and modify the models of three dimensional solid objects
  - There are number of representation techniques which are used for solid modeling like generating sweeps
  - A solid may be generated by using basic 3-D building blocks, which are called primitives
  - e.g. Block is a primitive whose attributes are length, height and width
  - These different primitives are combined to form a real model
  - The basic primitives used are block, cylinder, sphere, wedge, and cone etc.

MODELING TECHNIQUES

- Certain modeling techniques are as follows
  - Primitive Based Modeling
  - Variational Modeling
  - Feature Based Modeling
  - Pure Primitive Modeling
  - Constraint Driven Modeling
  - Design Table Based Modeling

MODELING TECHNIQUES

- ***Primitive Based Modeling***

➢ A primitive is a standard solid elememt like cube, cylinder, sphere and cone etc.

➢ The basic primitives are combined with boolean algebra (union, subtraction, Intersection etc.)

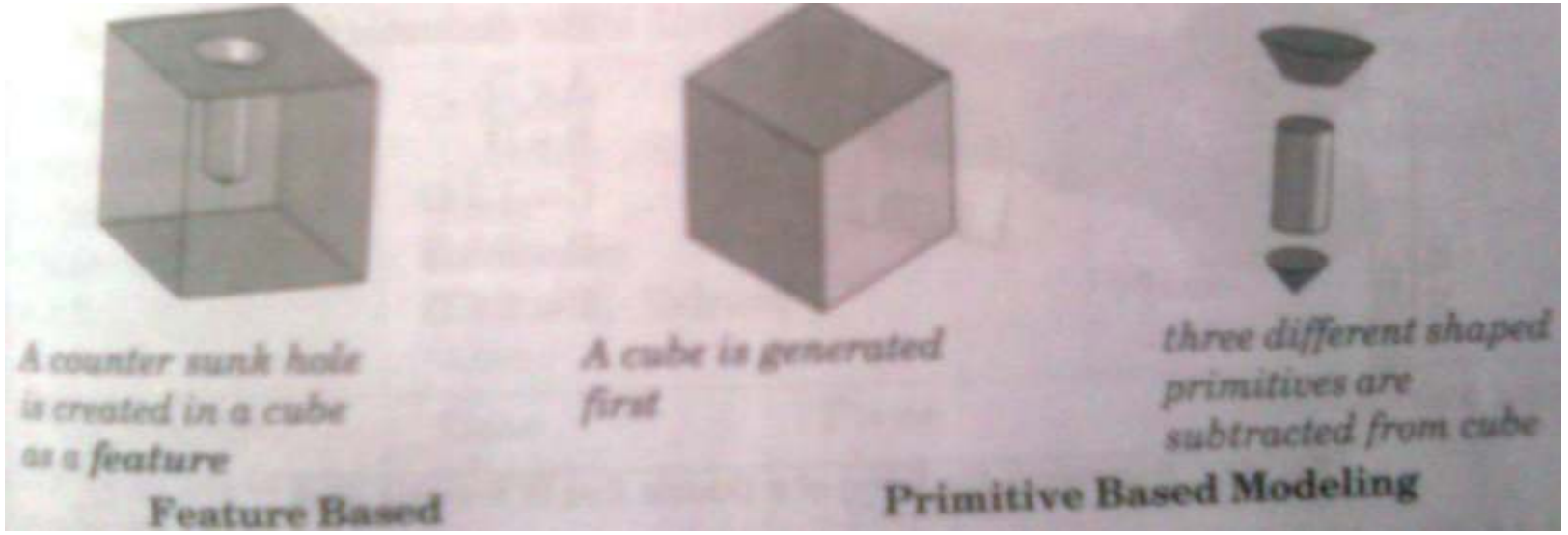
MODELING TECHNIQUES

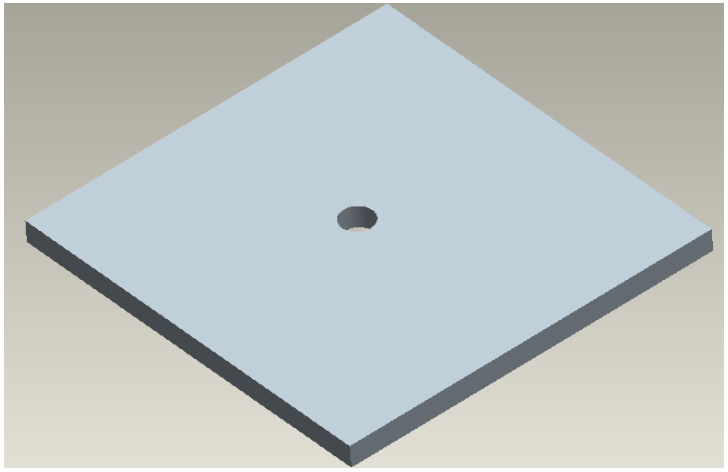
- ***Variational Modeling***
  - The variational approach couches the design in a mathematical model such that whenever the designer makes a change, the package recalculates the entire model
  - This capability makes a flexible system and it is most useful in early design stages where relationships between geometric constructions can change drastically

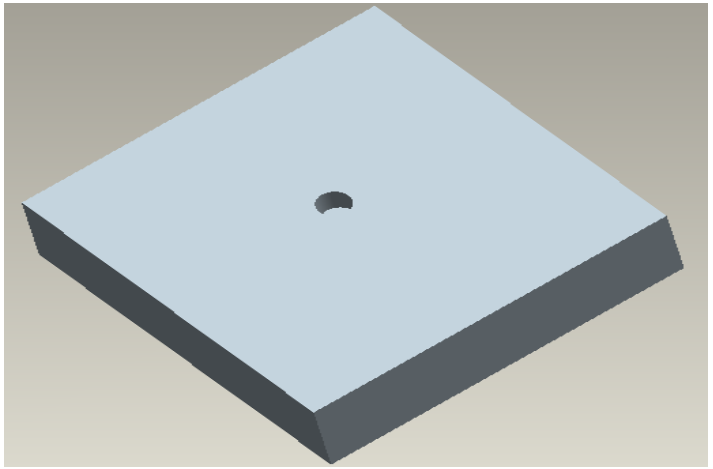
MODELING TECHNIQUES

- ***Feature Based Modeling***
  - Feature based modeling has rapidly become the preferred method of constructing models among engineers
  - In feature based modeling, models are constructed from geometric features such as holes, shells, bends, drafts, rounds rather than using primitives
  - The major advantage is that they provide dimensions that correctly define how the feature behaves when dimension change

MODELING TECHNIQUES

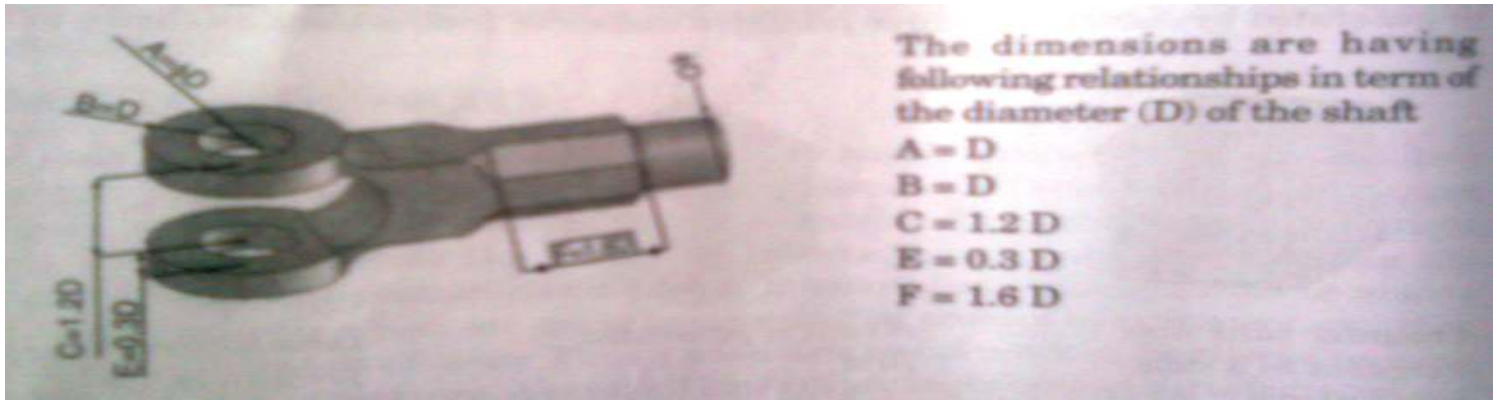






MODELING TECHNIQUES

- ***Pure Primitive Modeling***
  - Components like fasteners (nuts and bolts, screws, holes of various kinds) and jig and fixtures etc. Are made for a range of dimensions
  - Knowing the few important dimensions of the model, other dimensions can be calculated using empirical relationships



MODELING TECHNIQUES

- ***Constraint Driven Modeling***
  - In constraint driven modeling the modeling is done by imposing certain constraints on the model entities through equations
  - The design intent is defined through equations or relationships between existing entities e.g. The two circles can be constrained using a concentric constraint

MODELING TECHNIQUES

- ***Design Table Based Modeling***
- This design technique can assist in creating number of design alternatives with dimensional change of approximate similar shapes