

Velammal Institute of Technology

QUESTION BANK ME6501 Computer Aided Design

UNIT - I

FUNDAMENTALS OF COMPUTER GRAPHICS

PART - A

1. What is meant by Engineering Design Process?

The Engineering Design Process is the formulation of a plan to help an engineer build a product with a specified performance goal.

The Engineering Design process is a multi-step process including the research, conceptualization, feasibility assessment, establishing design requirements, preliminary design, detailed design, production planning and tool design, and finally production.

2. Shortly narrate Embodiment Design.

It is a process where the structured development of the design concepts takes place. It is in this phase that decisions are made on strength, material selection, size shape and spatial compatibility. Embodiment design is concerned with three major tasks – product architecture, configuration design, and parametric design.

3. What are the steps involved in Conceptual Design?

- i. Identification of customer needs
- ii. Problem definition
- iii. Gathering Information
- iv. Conceptualization
- v. Concept selection

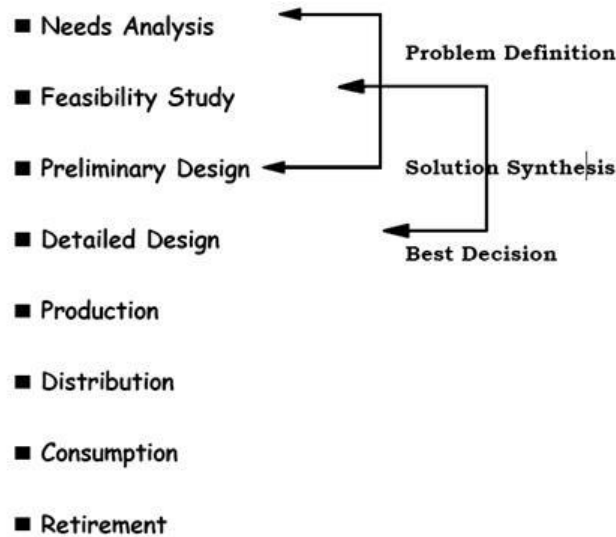
4. Describe Detailed Design.

It is in this phase the design is brought to a state where it has the complete engineering description of a tested and a producible product. Any missing information about the arrangement, form, material, manufacturing process, dimensions, tolerances etc of each part is added and detailed engineering drawing suitable for manufacturing are prepared.

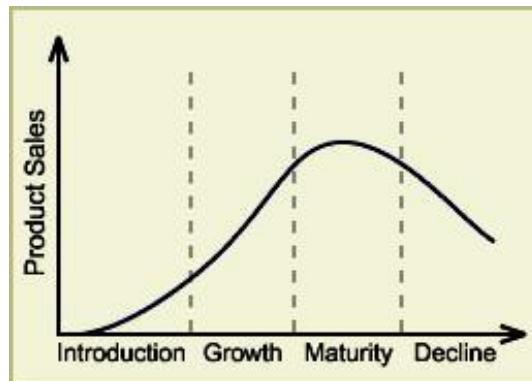
5. Why Technology is applied in the Design Process?

- Design is the essence of engineering
- Starts with recognition of some need
- Progresses to physical implementation
- Results may be simple or complex
- Design can be of two kind:
 - Something completely new , or
 - An improved form of something already in existence

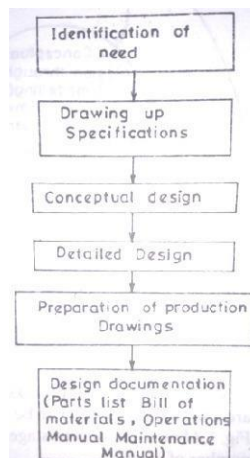
6. What are the steps involved in Morphology of Design?



7. Plot the various stages of Product Life Cycle (PLC).

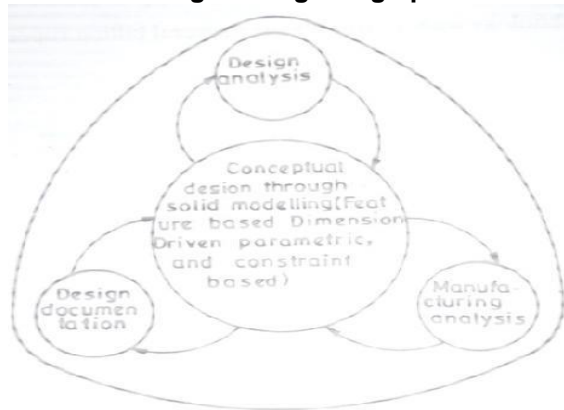


8. What are the stages of conventional sequential engineering design process?



89DeepakAravind - Ap/Mech

9. Clearly sketch components of concurrent engineering design process?



10. List the application of Computers to Design.

- Modeling of the Design
- Engineering design and analysis
- Evaluation of Prototype through Simulation and Testing
- Drafting and Design Documentation

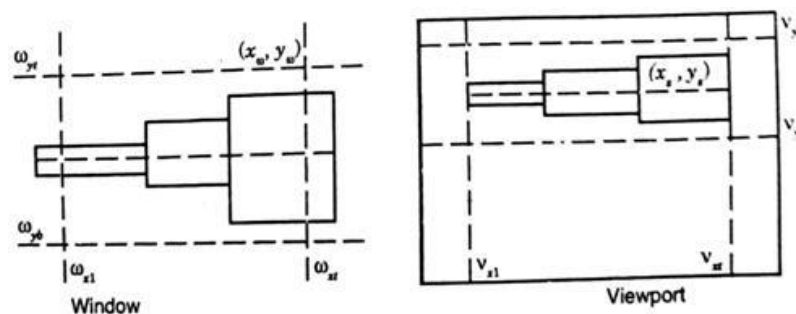
11. List any four benefits of CAD.

- Shorter Lead Times
- Flexibility in Design
- Design Analysis
- Fewer Design Error
- Standardization of Design, Drafting and Documentation
- Drawings are more understandable

12. Write short note on Windowing Transformation.

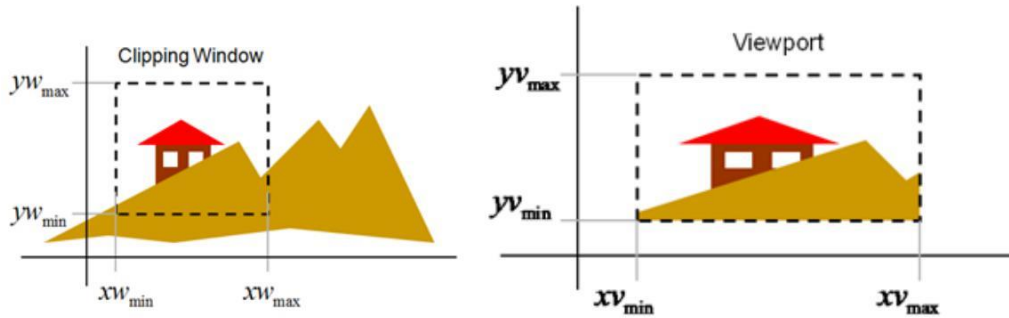
When it is necessary to examine in detail a part of a picture being displayed, a window may be placed around the desired part and the windowed area magnified to fill the whole screen and multiple views of the model may also be shown on the same screen.

The window is a rectangular frame or boundary through which the user looks onto the model. The viewport is the area on the screen in which the contents of the window are to be presented as an image.



13. What is meant by clipping Transformation?

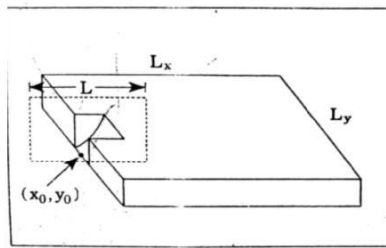
The clipping is an operation to plot part of a picture within the given window of the plotting area and to discard the rest.



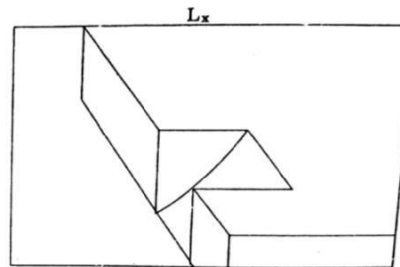
14. How Zooming has done in CG?

This transformation is carried out to provide enlarged or shrunk view of a picture detail

Zooming = scaling + translation + clipping



Original picture with portion to be enlarged



After zooming of marked area.

Translation : $D_x = -x_0, D_y = -y_0$ (Centre of detail to origin)

Scaling: $S_x = S_y = L_x/L$

Translation : $D_x = L_x/2, D_y = L_y/2,$

Clipping : (to frame dimensions)

15. List some 2 –D transformations.

- a. Translation
- b. Rotation
- c. Scaling
- d. Mirroring
- e. Clipping

UNIT-2 GEOMETRIC MODELING

PART - A

1. What are the two types of equations for curve representation?

- (1) Parametric equation x, y, z coordinates are related by a parametric variable (u or θ)
- (2) Nonparametric equation x, y, z coordinates are related by a function

Example: Circle (2-D)

Parametric equation

$$x = R \cos \theta, \quad y = R \sin \theta \quad (0 \leq \theta \leq 2\pi)$$

Nonparametric equation

$$x^2 + y^2 - R^2 = 0 \quad (\text{Implicit nonparametric form})$$

$$y = \pm \sqrt{R^2 - x^2} \quad (\text{Explicit nonparametric form})$$

2. Name some types of curves used in geometric modelling.

- Hermite curves
- Bezeir curves
- B-spline curves
- NURBS curves

3. What are the desirable properties of Bezier Curve?

- The curve passes through the first and last vertex of the polygon.
- The tangent vector at the starting point of the curve has the same direction as the first segment of the polygon.
- The n th derivative of the curve at the starting or ending point is determined by the first or last $(n+1)$ vertices.



4. Write any Two Drawbacks of Bezier Curves.

(1) For complicated shape representation, higher degree Bezier curves are needed.

→ Oscillation in curve occurs, and computational burden increases.

(2) Any one control point of the curve affects the shape of the entire curve.

→ Modifying the shape of a curve locally is difficult.

5. List the advantages of B-spline curves.

(1) The order of the curve is independent of the number of control points. (1) The order of the curve is independent of the number of control points. (1) The order of the curve is independent of the number of control points.

- User can select the curve's order and number of control points. - User can select the curve's order and number of control points. - User can select the curve's order and number of control points.

(2) Modifying the shape of a curve locally is easy. (2) Modifying the shape of a curve locally is easy. (2) Modifying the shape of a curve locally is easy.

- Each curve segment is affected by k (order) control points. - Each curve segment is affected by k (order) control points. - Each curve segment is affected by k (order) control points.

6. What are the functions of Geometric Modelling in design analysis?

Evaluation of area, volume, mass and inertia properties
Interference checking in assemblies

Analysis of tolerance build-up in assemblies
Kinematic analysis of mechanisms and robots
Automatic mesh generation for finite element analysis

7. What are the functions of Geometric Modelling in Manufacturing??

Parts classification
Process planning
NC data generation and verification
Robot program generation
Scheduling

8. List the Properties of a Geometric Modeling System.

The geometric model must stay invariant with regard to its location and orientation
The solid must have an interior and must not have isolated parts

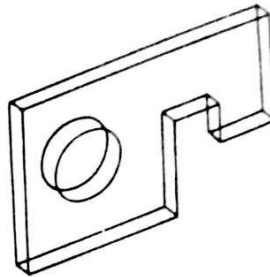
The solid must be finite and occupy only a finite shape

The application of a transformation or Boolean operation must produce another solid
The solid must have a finite number of surfaces which can be described

The boundary of the solid must not be ambiguous

9. What are called 2 ½ - D Wire frame models?

Two classes of shape for which a simple wire-frame representation is often adequate are those shapes defined by projecting a plane profile along its normal or by rotating a planar profile about an axis. Such shapes are not two-dimensional, but neither do they require sophisticated three-dimensional schemes for their representation. Such representation is called 2 ½ - D.

10. Draw an example for 2 ½ - D Wire frame model.**11. Catalog Techniques In Surface Modelling.**

- i. Surface Patch
- ii. Coons Patch
- iii. Bicubic Patch
- iv. Be'zier Surface
- v. B-Spline Surfaces

12. What are the Solid Modeling Techniques?

The various methods for representing the solids are:

1. Half-space method
2. Boundary representation method (B-rep)
3. Constructive solid geometry (CSG and C-rep)
4. Sweep representation
5. Analytical solid modeling (ASM)
6. Primitive instancing
7. Spatial partitioning representation
 - a. Cell decomposition
 - b. Spatial occupancy enumeration
 - c. Octree encoding

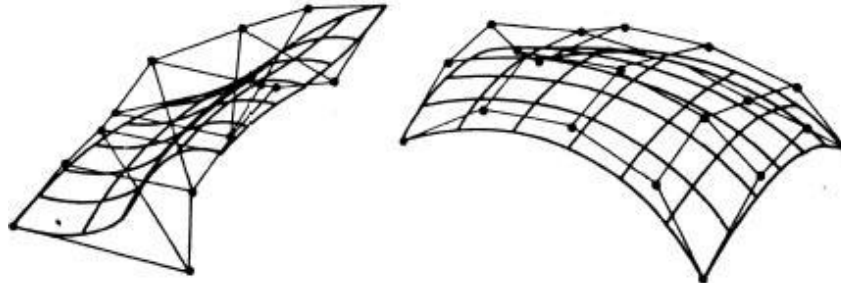
13. Write short note on Be'zier Surface.

- The Be'zier s urface formulation use a characteristic
- polygon Points the Be zier surface are given by

$$\vec{p}(u, v) = \sum_{i=0}^m \sum_{j=0}^n \vec{B}_{i,m}(u) \vec{B}_{j,n}(v) \vec{p}_{ij}; u, v, \in [0, 1]$$

Where,

- \vec{p}_{ij} ; - Vertices of the characteristic polygon
- $\vec{B}_{j,n}, \vec{B}_{i,m}$ - Blending functions



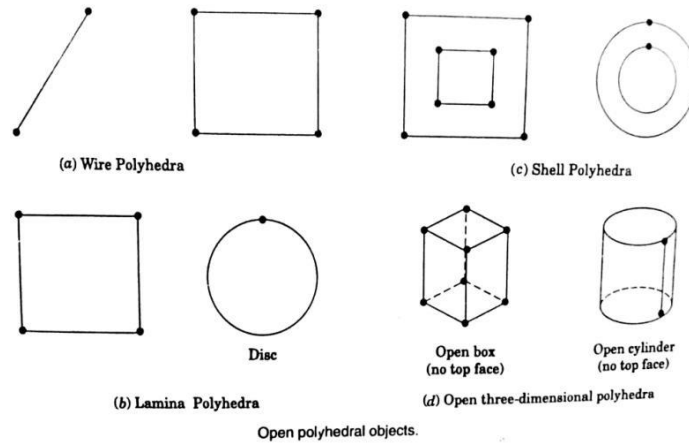
14. Write any topological terms used Boundary representation method (B-rep).

- Vertex (V): It is a unique point (an ordered triplet) in space
- Edge (E): It is finite, non-self intersecting, directed space curve bounded by two vertices that are not necessarily distinct
- Face (F): It is defined as a finite connected, non-self-intersecting, region of a closed oriented surface bounded by one or more loops
- Loop (L) : It is an ordered alternating sequence of vertices and edges
- Genus(G) : It is the topological name for the number of handles or through holes in an object
- Body/Shell(B) : It is a set of faces that bound a single connected closed volume. A minimum body is a point

15. What is called singular body in b-rep?

A minimum body is a point; topologically this body has one face, one vertex, and no edges. It is called a seminal or singular body

16. Sketch some open polyhedral objects used in B-rep.



17. Write Euler’s formula for open and closed objects used in b-rep.

Euler – Poincare Law for closed objects :

$$F - E + V - L = 2 (B - G)$$

Euler – Poincare Law for open objects :

$$F - E + V - L = B - G$$

18. What are Advantages and Disadvantages of b-rep?

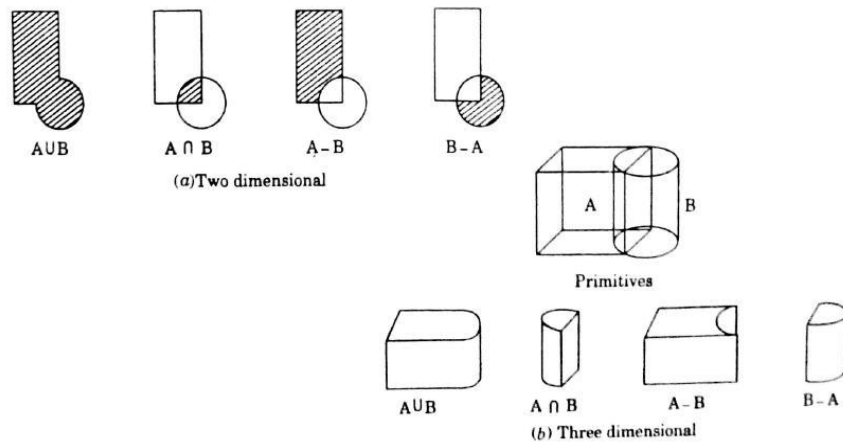
Advantages

- Appropriate to construct solid models of unusual shapes
- Relatively simple to convert a b-rep model to wireframe model

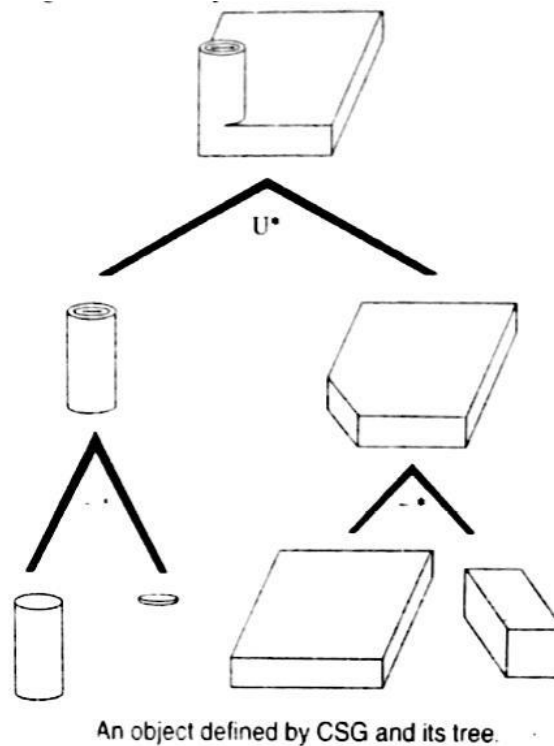
Disadvantages of b-rep

- Requires more storage
- Not suitable for applications like tool path generation
- Slow manipulation

19. How solids are created using CSG?



20. Give an example for CS G Tree.



UNIT-3 VISUAL REALISM

PART - A

1. List some hidden-space algorithms.

- Depth –Buffer Algorithm
- Scan-line coherence Algorithm
- Area-coherence algorithm (Warnock’s algorithm)
- Priority algorithm (Newell, Newell and Sancha algorithm)

2. Enumerate usage of Shading in Computer Graphics.

Shading is used in drawing for depicting levels of darkness on paper by applying media more densely or with a darker shade for darker areas, and less densely or with a lighter shade for lighter areas. There are various techniques of shading including cross hatching where perpendicular lines of varying closeness are drawn in a grid pattern to shade an area. The closer the lines are together, the darker the area appears. Likewise, the farther apart the lines are, the lighter the area appears.

3. What are the two main ingredients in shading of model?

- Properties of the model surface
- Properties of illumination falling on it

4. Differentiate Point and Spotlight lighting.

Point lighting

Light originates from a single **point**, and spreads outward in all directions.

Spotlight lighting

Models a **Spotlight**. Light originates from a single point, and spreads outward in a **cone**.

5. Distinguish Flat and Smooth shading.

Flat Shading	Smooth shading
Uses the same color for every pixel in a face - usually the color of the first vertex.	Smooth shading uses linear interpolation of colors between vertices
Edges appear more pronounced than they would on a real object because of a phenomenon in the eye known as lateral inhibition	The edges disappear with this technique

Same color for any point of the face	Each point of the face has its own color
Individual faces are visualized	Visualize underlying surface
Not suitable for smooth objects	Suitable for any objects
Less computationally expensive	More computationally expensive

6. Enumerate Painter's algorithm.

It sorts polygons by their bary center and draws them back to front. This produces few artifacts when applied to scenes with polygons of similar size forming smooth meshes and back face culling turned on. The cost here is the sorting step and the fact that visual artifacts can occur.

7. How Warnock algorithm works?

It divides the screen into smaller areas and sorts triangles within these. If there is ambiguity (i.e., polygons overlap in depth extent within these areas), then further subdivision occurs. At the limit, subdivision may occur down to the pixel level.

8. What are the advantages and disadvantages of Depth-Buffer Algorithm?

Advantages

- Easy to implement
- Hardware supported
- Polygons can be processed in arbitrary order-
- Fast: $\sim \# \text{polygons}, \# \text{covered pixels}$

Disadvantages

- Costs memory

9. What are the advantages and disadvantages of Ray-casting Algorithm in hidden surface removal?

Advantages

- + Relatively easy to implement
- + For some objects very suitable (for instance spheres and other quadratic surfaces)
- + Transparency can be dealt with easily
- Objects must be known in advance
- Slow: $\sim \# \text{objects} * \text{pixels}$, little coherenc

10. List the two types of smooth shading.

- Gouraud shading
- Phong shading

11. Write short note on Gouraud shading.

1. Determine the normal at each polygon vertex
2. Apply an illumination model to each vertex to calculate the vertex intensity
3. Interpolate the vertex intensities using bilinear interpolation over the surface polygon

12. Write Advantages of Gouraud shading.

Polygons, more complex than triangles, can also have different colors specified for each vertex. In these instances, the underlying logic for shading can become more intricate.

13. What are the Problems encountered in Gouraud shading?

- Even the smoothness introduced by Gouraud shading may not prevent the appearance of the shading differences between adjacent polygons.
- Gouraud shading is more CPU intensive and can become a problem when rendering real time environments with many polygons.
- T-Junctions with adjoining polygons can sometimes result in visual anomalies. In general, T-Junctions should be avoided.

14. List some highlights of Phong shading over Gouraud shading model.

Phong shading is similar to Gouraud shading, except that the Normals are interpolated. Thus, the specular highlights are computed much more precisely than in the Gouraud shading model:

- a. Compute a normal N for each vertex of the polygon.
- b. From bilinear interpolation compute a normal, N_i for each pixel. (This must be renormalized each time)
- c. From N_i compute an intensity I_i for each pixel of the polygon.
- d. Paint pixel to shade corresponding to light.

15. Catalog Hidden surface removal algorithms

- i. Z-buffering
- ii. Coverage buffers (C-Buffer) and Surface buffer (S-Buffer)
- iii. Sorted Active Edge List
- iv. Painter's algorithm
- v. Binary space partitioning (BSP)
- vi. Ray tracing
- vii. The Warnock algorithm

ASSEMBLY OF PARTS

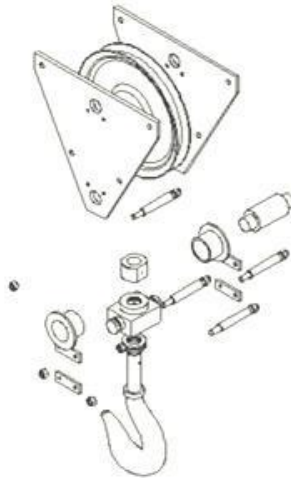
PART - A**1. Define Assembly modeling.**

Assembly modeling is defined as a technology and method used by computer-aided design and product visualization computer software systems to handle multiple files that represent components within a product. The components within an assembly are represented as solid or surface models.

2. Write short note on Exploded view.

An exploded view consists of series of steps. One can create steps by selecting and dragging parts in graphical area.

Example – Exploded view of Assembly of Pulley block

**3. List Features of Bottom-up assembly approach.**

- Allows the designer to use part drawings that already exist (off the shelf)
- Provides the designer with more control over individual parts
- Multiple copies (instances) of parts can be inserted into the assembly

4. List Features of Top-down assembly approach.

- The approach is ideal for large assemblies consisting of thousands of parts.
- The approach is used to deal with large designs including multiple design teams.
- It lends itself well to the conceptual design phase
- E.g. :
 - Piping and fittings
 - Welds
 - Lock pins

5. List advanced Mating conditions in assembling modeling.

- Distance
- Linear/linear coplanar
- Path
- Width
- Symmetry
- Angle

6. Applications of Assembly Models Interference checking Visualization

- Rendered
- Exploded
- Animation
- Mechanism analysis

7. Assembly sequence affects

- difficulty of assembly steps
- need for fixture
- potential for parts damage during assembly and part mating
- ability to do in-process testing
- occurrence of the need for reworking
- time of assembly
- assembly skill level
- unit cost of assembly

8. Interference fit

- Fits is clearance fit
- tight fits is interference fit
- Coplanar: two normal vectors are parallel
- 'Coplanar' complements 'against'

9. Sketch the Precedence Diagram.

- Designed to show all the possible assembly sequences of a product.
- Each individual assembly operation is assigned a number.
- Diagram is usually organized into columns

10. What are the three terms used in limit system?

1. **Tolerance:** Deviation from a basic value is defined as Tolerance. It can be obtained by taking the difference between the maximum and minimum permissible limits.
2. **Limits:** Two extreme permissible sizes between which the actual size is contained are defined as limits.
3. **Deviation:** The algebraic difference between a size and its corresponding basic size. There are two types of deviations: 1) Upper deviation 2) Lower deviation

11. Write short note on Tolerances.

Due to human errors, machine settings, etc., it is nearly impossible to manufacture an absolute dimension as specified by the designer. Deviation in dimensions from the basic value always arises. This deviation of dimensions from the basic value is known as Tolerance.

12. Define Clearance fit.

Clearance fit is defined as a clearance between mating parts. In clearance fit, there is always a positive clearance between the hole and shaft.

13. Why Transition fit occurs?

Transition fit may result in either an interference or clearance, depending upon the actual values of the tolerance of individual parts.

14. When Interference fit is obtained?

Interference fit is obtained if the difference between the hole and shaft sizes is negative before assembly. Interference fit generally ranges from minimum to maximum interference. The two extreme cases of interference are as follows:

15. What is called Minimum interference?

The magnitude of the difference (negative) between the maximum size of the hole and the minimum size of the shaft in an interference fit before assembly.

UNIT - V

CAD STANDARDS

PART - A**1. List some Standards used in computer graphics.**

- **GKS** (Graphical Kernel Systems)
- **PHIGS** (Programmer's Hierarchical Interface for Graphics)
- **CORE** (ACM-SIGGRAPH)
- **GKS-3D**
- **IGES** (Initial Graphics Exchange Specification)
- **DXF** (Drawing Exchange Format)
- **STEP** (Standard for the Exchange of Product Model Data)
- **DMIS** (Dimensional Measurement Interface Specification)
- **VDI** (Virtual Device Interface)
- **VDM** (Virtual Device Metafile)
- **GKSM** (GKS Metafile)
- **NAPLPS** (North American Presentation Level Protocol Syntax)

2. What are the Types of Standards used in CAD?

- Graphics Standards
- Data Exchange Standards
- Communication Standards

3. Write Aim of Graphics Standardization.

- To provide versatility in the combination of Software and Hardware items of turnkey systems
- To allow the creation of portable application software package, applicable for wide range of hardware makes enumand configurations

4. Enumerate GKS 3D.

The GKS has been subsequently enhanced to provide a separate standard for the three dimensions as GKS 3D, which maintains compatibility with the 2D standard.

5. Write short note on PHIGS.

The other 3D graphic standard accepted by the CAD vendors as animation. Some of the features following:

- very high interactivity
- hierarchical structuring of data
- real time modification of graphic data
- support for geometric animation
- adaptability to distributed user environment

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6. Write short note on NA PLPS.

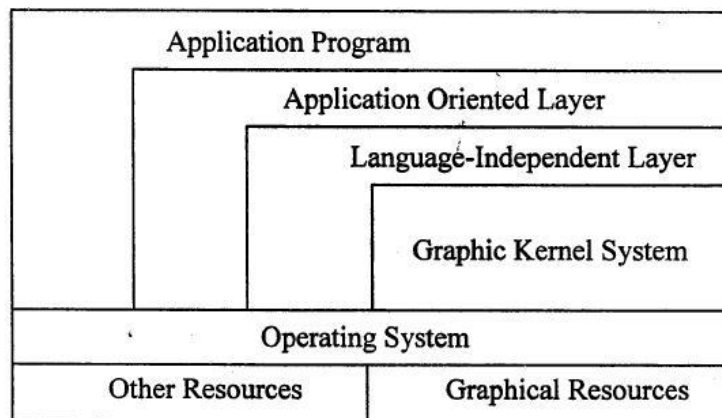
The North American Presentation Level Protocol Syntax (NAPLPS) is the presentation standard developed jointly by the Canadian government and AT & T and other computer communication companies as *a basis for transferring data from computers to the video display systems such as teletext and other video presentation systems.*

7. List the features of NAP LPS.

The NAPLPS is a means of encoding the graphic data consisting of both graphical and text data in an electronically transferable format (ASCII). Some of the major features of NAPLPS (ASCII). Some of the features are:

- The NAPLPS code is compact and is roughly about 10 per cent in comparison with other graphic formats.
- The graphic format used is resolution-independent. As a result, if the output is displayed on a lower resolution system is displayed on a higher resolution system the output is clear.
- The NAPLPS is capable of being integrated into all communication channels such as television broadcasting signals, video tapes, etc.
- The colour look-up tables form part of NAPLPS transmission which enable the colours to be produced instantaneously on the host system.

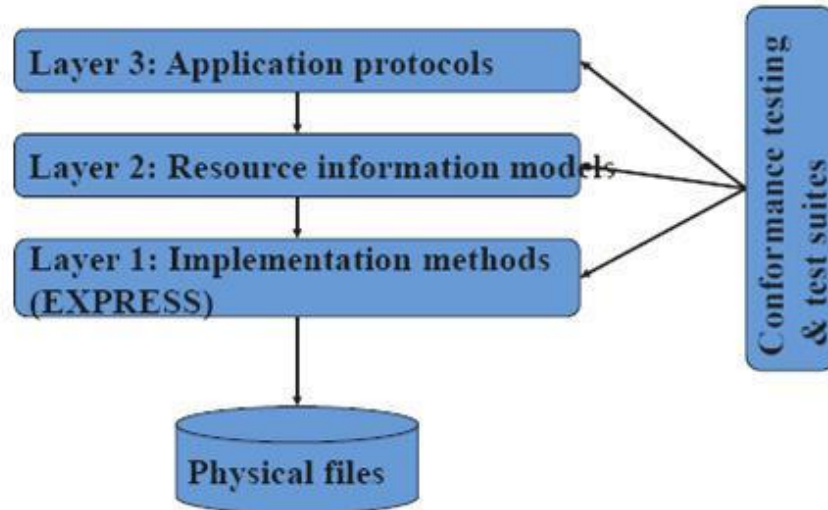
8. Sketch the layer model of GKS.



9. Write features of Continuous Acquisition and Life-cycle Support (CALS).

- Developed by U S Department of Defense
- Prescribes formats for storage and exchange of technical data
- Technical publications an important focus

10. Sketch STEP Architecture.



11. List the Classes of STEP Parts.

- Introductory
- Description methods
- Implementation methods
- Conformance testing methodology and framework
- Integrated resources
- Application protocols
- Abstract test suites

12. What are Important CALS Standards?

- Standard Generalized Markup Language (SGML)
- Computer Graphics Metafile (CGM)

13. Note on Computer Graphics Metafile (CGM).

Developed in 1986

vector file format for illustrations and drawings

All graphical elements can be specified in a textual source file that can be compiled into a binary file or one of two text representations

14. **What is meant by OpenGL (Open Graphics Library)?**

OpenGL is a cross-language, multi-platform application programming interface (API) for rendering 2D and 3D vector graphics. The API is typically used to interact with a graphics processing unit (GPU), to achieve hardware-accelerated rendering.

15. **List Graphics primitives in GKS with sketch.**

