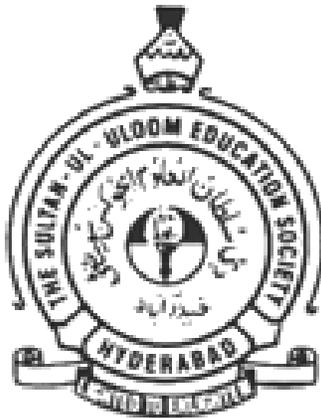


MANUAL

For

CAPD Laboratory

B.E Mechanical & Production



**Mechanical Engineering Department
Muffakham Jah College of Engineering and Technology
Banajra Hills, Road No.3, Hyderabad-500034**

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MP 433**COMPUTER AIDED PRODUCTION DRAWING LAB**

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessional	25 Marks

PART DRAWINGS: Prepare the part drawings with production drawing details of the following assemblies using modeling softwares solid works / Solid Edge / CATIA/ProE/Auto CAD-MDT/ NX

Sheet No. Topic

- 1 Steam Engine Cross Head
- 2 Steam Engine Connecting Rod End
- 3 Non Return Valve
- 4 Blow – off cock
- 5 Drill Jig (Plate type)

Suggested Reading :

1. K. L. Narayana, P. Kannaiah and K. Venkat Reddy, *Production Drawing*, New Age International (P) Ltd. Revised edition 1997.
2. P. Narasimha Reddy, T.A. Janardhan Reddy and C. Srinivas Rao, *Production Drawing Practice*, Hi-Tech Publishers, 2001.

LIST OF EXPERIMENTS

1. Introduction to production drawing and solid works.
2. Prepare the part drawings with production drawing details of Steam Engine Cross Head.
3. Prepare the part drawings with production drawing details of Drill Jig (Plate type).
4. Prepare the part drawings with production drawing details of Steam Engine Connecting Rod End.
5. Prepare the part drawings with production drawing details of Non Return Valve.
6. Prepare the part drawings with production drawing details of Blow – off cock.

CONTENTS

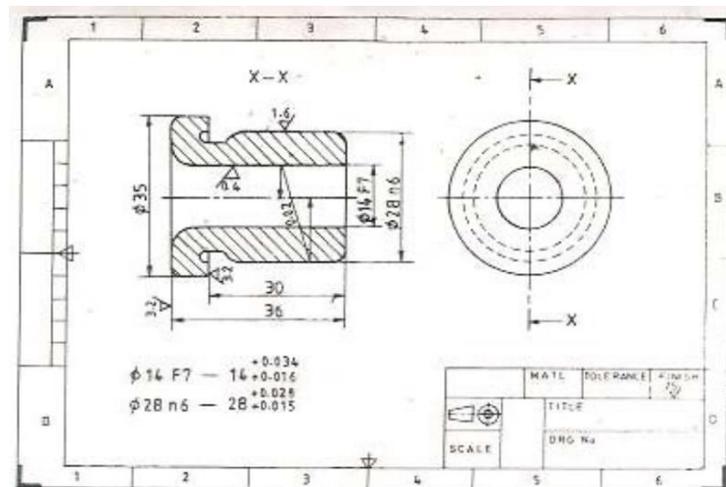
Ex. No.	Title of the exercise	PG. NO.
1.	Introduction to Production Drawing	1-5
2.	Introduction to CAD	6-16
3.	Introduction to SOLID WORKS	17-21
4.	Production drawing details of Steam Engine Cross Head.	22-25
5.	Production drawing details of Drill Jig (Plate type)	26-29
6.	Production drawing details of Steam Engine Connecting Rod End.	30-32
7.	Production drawing details of Non Return Valve.	33-35
8.	Production drawing details of Blow – off cock.	36-37

INTRODUCTION

PRODUCTION DRAWING

A component or part drawing is termed as a production drawing, if it facilitates its manufacture. It is an authorized document to produce the component in the shop floor. It furnishes all dimensions, limits and special finishing processes such as heat treatment, grinding, etc., in addition to the material used. It should also mention the number of parts that are required for making of the assembled unit, of which the part is a member.

Production drawing of a component should also indicate the sub or main assembly where it will be assembled. It is necessary to prepare the production drawing of each component on a separate sheet, since a craftsman will ordinarily make one component at a time. However, in some cases, the drawings of related components may also appear on the same sheet. Figure 1 shows the production drawing of a jig bush.



Need for a production drawing

The graphic representation of a product starts at the transformation stage of ideas into a drawing by a design engineer. A production drawing is a complete working drawing, representing all the details of the product, regarding size, shape, material, process, tools and equipment. The craftsman is completely guided by the production drawing, during the manufacture of the product. Hence, any mistake in a production drawing will result in loss of time, money and decreased productivity. Further, it is a legal document while going for subcontracting of works. Hence, a production drawing should be prepared without any scope for more than one interpretation.

The design engineer uses orthographic or pictorial views to record his ideas, free hand. These are called working sketches. These sketches are used for both the component and assembly drawings. The working drawings are sent to the shop, in the form of blue prints, ammonia prints or other similar forms of reproduction. Therefore, the drawings must be made as tracings.

Elements of production drawing

Following are the basic elements of a production drawing.

1. Format of drawing sheet,
2. Size and shape of the component,
3. Projection method,
4. Material specification and shape such as castings, forgings, plates, rounds, etc.,
5. Indication of surface roughness and other heat treatments, if any,
6. Limits, fits and tolerances of size, form, and position,
7. Production method,
8. Process sheet,
9. Specification of standard components,
10. Conventions used to represent certain machine components, and
11. Inspection and testing methods.

Drawing Sheet Sizes

Drawing paper and cloth are available in rolls of various widths and in standard trimmed sizes. Most of the drafting rooms use standard sheets, printed with border and title block. There are five standard sizes for drawing sheets (First choice), specified by Bureau of Indian Standards (BIS) SP: 46-1988, as given below in table 1. The standard sizes help save paper and are also convenient for storing.

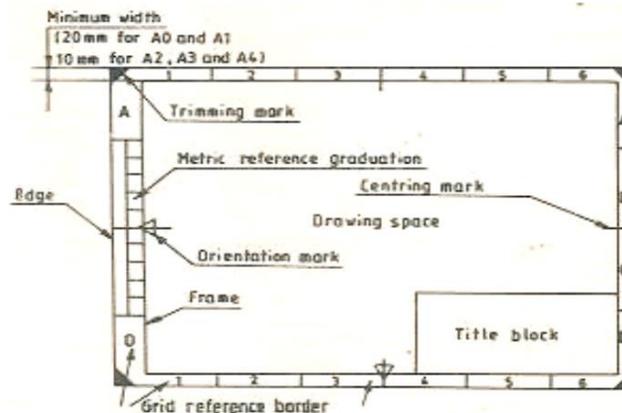
Designation	Dimension (mm)
A0	841 X 1189
A1	594 X 841
A2	420 X 594
A3	297 X 420
A4	210 X 297

Drawing sheets may be used with their longer sides positioned horizontally or vertically. The original drawing should be made on the smallest sheet, permitting the necessary clarity and resolution.

Drawing sheet layout

The layout of a drawing sheet should, by the clarity and neatness of its appearance, facilitate the reading of the drawing. It should also facilitate essential references to be located easily. Borders, enclosed by the edges of the trimmed sheet and the frame, limiting the drawing space shall be provided with all the sheet sizes. It is recommended that these borders have a minimum width of 20 mm for the sizes A0 and A1 and a minimum width of 10 mm for other sizes. A file margin for taking perforations may be provided on the edges far left of the title block. It should have a minimum width of 20 mm.

Four centering marks shall be provided in order to facilitate positioning of the drawing, when reproduced or microfilmed. Two orientation marks may be provided to indicate the orientation of the drawing sheet on the drawing board. It is recommended to provide on all drawings, a figureless metric reference graduation, with minimum length of 100 mm and divided into 10 equal parts. The metric reference graduation shall preferably be disposed symmetrically about the centering mark, near the frame in the border, with a minimum width of 5 mm.



The provision of the grid reference system (zoning) is recommended for all sizes, in order to permit easy location on the drawing, of details, additions, modifications, etc. The number of divisions should be even and be chosen in relation to the complexity of the drawing. However, the length of any side of the rectangle shall be from 25 to 75 mm. The rectangles of the grid should be referenced by means of capital letters along one edge and numerals along the other. The numbering direction may start at the sheet corner, opposite to the title block and be repeated

on the opposite sides. The trimming marks may be provided in the borders, at the four corners of the sheet in order to facilitate trimming. These marks may be in the form of right angled isosceles triangles. The pre-printed drawing sheets when used should include the following features:

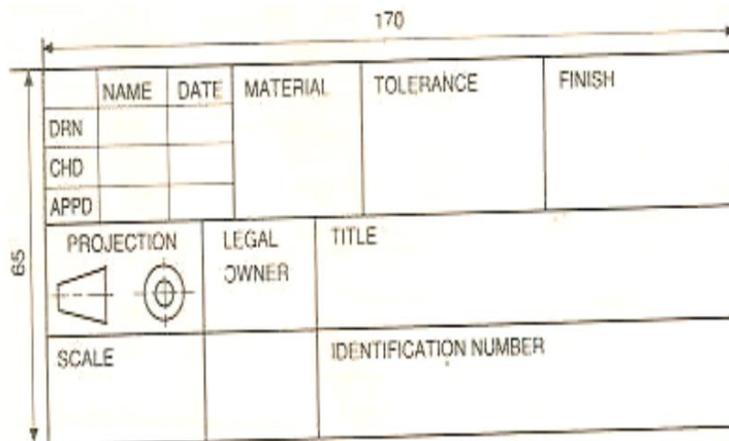
Title block,

1. Frame for limiting the drawing space,
2. Centring marks, and
3. Optional features: i) metric reference graduation, ii) grid reference system, and iii) trimming marks.

The drawing sheet layout must also provide a title block, which should be located at the bottom right hand corner of the sheet; both for sheets positioned horizontally or vertically, with a maximum length of 170 mm. This should provide the following basic information:

1. Title of the drawing,
2. Sheet number,
3. Scale (s),
4. Symbol, denoting the method of projection,
5. Name of the firm, and
6. Initials of the staff designed, drawn, checked and approved

The direction of viewing the title block should correspond in general, with that of the drawing. A typical layout of the title block is shown in Fig. 3. However, the heading inside the title block may be arranged as per the convenience, within the overall size specified.



A production drawing may include the following additional information, located either in the drawing sheet or in the title block:

1. Job order number,
2. Surface treatment, roughness, etc.,
3. Key to machining and other symbols,
4. A general note on tolerance on dimensions, not
5. individually toleranced,
6. Reference to tools, gauges, jigs and fixtures,
7. Parts list, and
8. Alternations and revisions.

Information on a drawing

Every drawing should be numbered. Some companies use serial numbers such as 70524 or a number with prefix or suffix, K2-70524 or 70524-K2. Many different numbering systems are in use, in which various digits of the drawing numbers indicate different things, such as model number of the machine and the general nature or use of the part.

If all the drawings are made to the same scale, the scale should be indicated in or near the title block. Otherwise, the individual scales should be indicated below the respective drawings. General notes can be given on the working drawings to specify the tolerances of dimensions. According to the BIS SP:46-1988, Engineering drawing practice for schools and colleges; first angle projection method only, is required to be followed. Specifications regarding general notes, material, heat treatment, finish, general tolerances and number required are located on or near the title block.

S.No.	Note	Meaning/Instruction
1.	Φ 25 DEEP 40	Drill a hole of diameter 25 mm, to a depth of 40 mm.
2.	Φ 10 CSK Φ 15	Drill a through hole of diameter 10 mm and countersink to get 15 mm on top.
3.	4 holes, Φ 12 CBORE Φ 15 DEEP 8	Drill through hole of Φ 12 mm, counterbore to a depth of 8 mm, with a Φ 15 mm, the number of such holes being four.
4.	6 holes, EQUI-SP Φ 17 CBORE FOR M 16 SOCKET HD CAP SCR.	Drill a through hole of Φ 17 and counterbore to insert a socket headed cap screw of M 16. Six holes are to be made equi-spaced on the circle.
5.	KEY WAY, WIDE 6 DEEP 3	Cut a key way of 6 mm wide and 3 mm depth.

CAD INTRODUCTION:

Computer-aided design is essentially based on a versatile and powerful technique called computer graphics, which basically means the creation and manipulation of pictures on a display device with the aid of a computer. Computer graphics originated at the Massachusetts institute of technology (MIT) in 1950 when the first computer-driven display, linked to a Whirlwind computer, and was used to generate some pictures. The first important step forward in computer graphics came in 1963 when a system called SKETCHPAD was demonstrated at the Lincoln Laboratory of MIT. This system consists of a cathode ray tube (CRT) driven by TX2 computer. The CRT had a keyboard and a light pen. Pictures could be drawn on the screen and then manipulated interactively by the user via the light pen.

This demonstration clearly showed that the CRT could potentially be used as a designer's electronic drawing board with common graphic operations such as scaling, translation, rotation, animation and simulation automatically performed at the 'push of a button'. At that time, these systems were very expensive; therefore they were adopted only in such major industries as the aircraft and automotive industries where their use in design justified the high capital costs. Another crucial factor preventing computer graphics from being generally applied to engineering industries was that there was a lack of appropriate graphics and application software to run on these systems. However, a computer-based design system was clearly emerging. Since these pioneering developments in computer graphics, which had captured the imagination of the engineering industry all over the world, new and improved hardware, which is faster in processing speed, larger in memory, cheaper in cost and smaller in size, have become widely available.

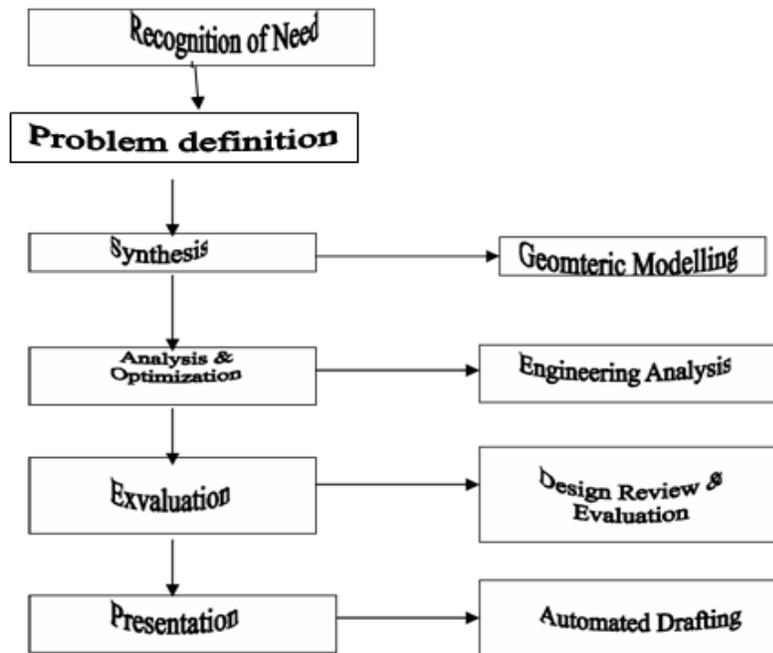
Sophisticated software techniques and packages have also been gradually developed. Consequently, the application of CAD in industry has been growing rapidly. Initially CAD systems primarily were automated drafting stations in which computer controlled plotters produced engineering drawings. The system were later linked to graphic display terminals where geometric model describing part dimensions were created, and the resulting database in the computer was then used to produce drawings. Nowadays, CAD systems can do much more than mere drafting. Some systems have analytical capabilities that allow parts to be evaluated with techniques such as the finite element method. There are also

kinematics analysis programs that enable the motion of mechanism to be studied. In addition, CAD system includes testing techniques to perform model analysis on structures, and to evaluate their response to pinpoint any possible defects.

Computer Aided Design is the process of developing and using computer assisted design tools in the design process. The advent of computers has contributed to significant advance in calculation, data handling and utilization applications. The ability to use the computers in these application areas enhances the capability of the design team significantly. Drafting and geometric modeling play significant roles in CAD. The module therefore concentrates on the general design process with specific consideration to drafting and geometric modeling. Three different CAD systems are referred to in the module. The syllabus includes: historical development, the design process, traditional drawing practice and the development of the CAD industry, system hardware, computers micros to mainframes, output devices, storage, workstations, networked systems, examples of CAD systems; simple entity descriptions: points, lines, arcs, made-edge lists, free-form curves, free-form surfaces; transformations: pan, rotate and scale, 3D transformations, observer angles, perspective, depth cueing; geometric modeling: wire frame modelers, surface modelers, solid modelers (CSG and B- rep), hidden line removal and mass properties; user interface: input devices, menus, graphics interface language, parametric. **LEARNING OBJECTIVES:** To understand and handle design problems in a systematic manner. To be able to use the capabilities provided by computers for calculations, data handling and visualization applications. To gain practical experience in handling 2D drafting and 3D modeling software systems. To be able to apply CAD in real life applications.

ROLE OF COMPUTERS IN DESIGN:

As manual design process has several risk factors including human fatigue and the evolution of design based on his previous experience. With the advent of computer and the development in the field of computer graphics, various design & manufacturing process takes place new faster rate with minimum or optimum error. The below figure shown the implementation of computer in design:



COMPUTERS IN DESIGN

Implementation of computer in the design stage becomes the subset of design process. Once the conceptual design materializes in the designer mind the geometric model starts by the appropriate CAD software. The choice of geometric model to CAD is analogous to the choice. The various design related tasks which are performed by a modern computer-aided design system can be grouped into four functional areas :

1. Geometric Modeling
2. Engineering Analysis
3. Design review and evaluation
4. Automated drafting.

Geometric Modeling:

It is concerned with the computer compatible mathematical description of the geometry of an object. The mathematical description allows the image of the object to be displayed & manipulated on a graphics terminal through signals from the CPU of the CAD system. The

software that provides geometric modeling capabilities must be designed for efficient use both by the computer & the human designer.

During the geometric modeling computer converts the command into a mathematical model, stores it in the computer data files, and display it as an image on the CRT screen. Object can be represented by geometric model by wireframe, surface model or solid model. Another feature of CAD system is color graphics capability. By means of color, it is possible to display more information on the graphics screen.

Engineering Analysis :

The analysis may involve stress-strain calculation, heat transfer computation etc., of the system being displayed. The computer can be used to aid in this analysis work. It is often necessary that specific programs be developed internally via the engineering analysis group to solve particular design problem. In other situation, commercially available general purpose programs can be used to perform the engineering analysis. Analysis may be:

- a. *Mass property analysis.*
- b. *Finite element analysis.*

The analysis of mass properties is the analysis feature of CADsystem which provides properties of solid object being analyzed, such as the surface area, weight, volume, centre of gravity and moment of inertia.

In FEA the object is divided into large number of finite elements which form an interconnecting network concentrated node. By using a computer with significant computational Capabilities, the entire object can be analyzed for stress- strain, heat transfer coefficient at nodes. By determining the interrelating behaviors of all nodes in the system, the behavior of the entire object can be assessed.

Design review & Evaluation;

Checking the accuracy of the design can be accomplished conveniently on the graphical terminal. Semiautomatic dimensioning and tolerance routines which assign size specification to surface indicated by the user help you to reduce the possibility of dimensioning errors. The designer can zoom icon part design details and magnify the

image on the graphics screen for close scrutiny. One of the most important evaluation features available on some computer aided design systems is KINEMATICS. The available kinematics packages provide the capability to animate the motion of the simple designed mechanisms such as hinged component & linkages. Commercial kinematics software available is ADAMS (Automatic Dynamic Analysis of Mechanical Systems).

Automated Drafting:

It involves the creation of hard-copy engineering drawings directly from the CAD data base. Most of the CAD systems are capable of generating as many as six views of the parts. Engineering drawings can be made into company drafting standard by programming the standards into the CAD system.

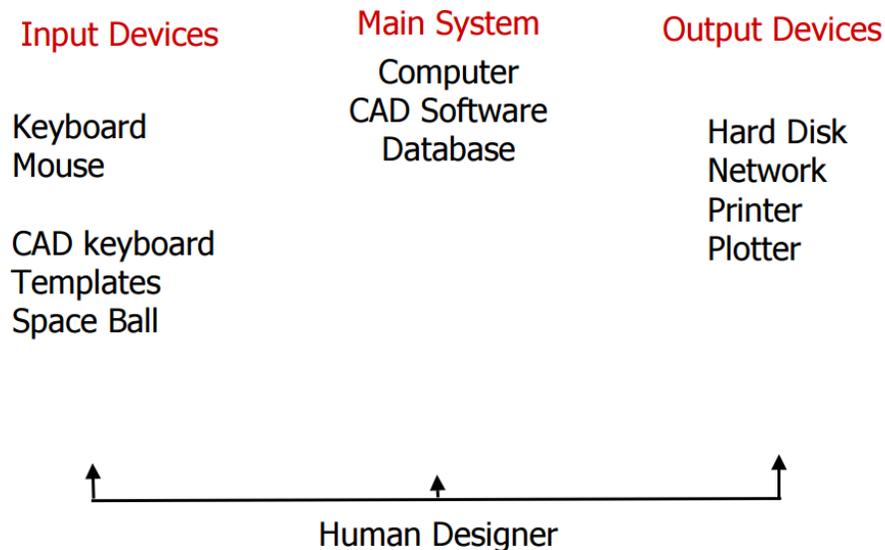
Implementation of computer in the design stage becomes the subset of design process. Once the conceptual design materialize in the designer mind the geometric model starts by the appropriate CAD software. The choice of geometric model to CAD is analogous to the choice of a mathematical model to engineering analysis.

A valid geometric model is created by definition translator, which converts the designer input into the proper database format. In order to apply engineering analysis in geometric model, interface algorithms are provided by the system to extract the required data from the model database to perform the analysis. In case of FEA, these algorithms from the finite element modeling package of the system. Design testing & evaluation may require changing the geometric model before finalizing it. When the final design is achieved the drafting & detailing of the model starts, followed by documentation & production of final drawings.

COMPONENTS OF CAD SYSTEM

The components of a typical CAD system are illustrated in the following figure. The central processing unit (CPU) is the brain of the entire system. It contains of integrated circuits of (IC) of three parts – ALU, controller and main memory unit. The arithmetic logic unit (ALU) consists of electronic circuits, which perform logic and mathematical

operations. Controller circuits are used to regulate various operations carried out in the computer. Main memory circuits store processed data, such as results of calculations and program instructions inside the computer. Hundreds of electronic circuits are reduced and etched on chip as small as a pinhead. The CPU is, therefore, one of the miracles of modern electronic technology.



Elements of CAD system

There are two types of magnetic disks – flexible and hard. The appearance of flexible disk is similar to that of a phonographic record. It is, however, thin and flexible compared with records, hence name floppy disk. The flexible disk is made of plastic like material – Mylar – with a thin coating of magnetic material such as ferric oxide. The data can be stored on the one side of the disk (single) or on both surfaces (dual). The standard diameters of floppy disks are 131mm and 200mm the disk is always kept in a square vinyl jacket for protection against dust particles and scratching. There is a small cut section in the jacket, called window. Reading and writing is accomplished through this window by means of a drive-head. The speed of rotation of the disk is usually 300r.p.m. The construction of the hard disk is similar to that of a flexible disk. It is, however, made from thin aluminum plate coated with ferric oxide. The disk is usually sealed in an airtight container and rotates at a much faster speed of 3600rpm. This increases speed of storage and retrieval of information.

A hard disk is more durable than a floppy disk. Cost is the main limitation of this disk. There are two methods to store data on flexible as well as hard disks – sequential and random access methods. In the sequential search method, data are stored in a sequence and the drive head has to search for a piece of information, starting from the beginning of the track. This increases the search depending upon the location of the information. The random access method is also called the direct access method. In this method, data stored on the disk are divided into two or more sections. When the section number is specified, the drive head directly moves to the relevant section and starts searching the data. Random access method is a faster method of data retrieval.

The computer systems used for CAD are of three types – mainframe, mini and micro. The mainframe system consists of a large capacity computer kept in a remote air-conditioned room. Strict environmental controls are needed for this system. The workstations are located at some distance from this central system. The mainframe system executes a number of functions, CAD being one of them. This system is more powerful than mini or micro systems, with fast computing speeds. Due to large memory capacity it can process the most difficult programs. Compared with the mainframe system, the microcomputer is small and inexpensive. It, however, operates at a slightly lower speed and is not able to process some of the difficult programs, which can be run on the mainframe system. Minicomputers are usually housed in an air-conditioned room. The microcomputer is the smallest type of CAD system. It does not require strict environmental controls. A graphic display station and keyboard is normally combined in to a micro unit. These units are called desktop computers. A microcomputer system is called a dedicated system, because it operates for the sole purpose of one user at a time. This system is cheap and easily available, but has limited capacity and speed.

The workstation is a visible part of the CAD system, which provides interaction between the operator and the system. There are two elements of a basic workstation – a CRT display and an alphanumeric keyboard. Other input devices, such as cursor control devices, digitizers and graphic tablets, are provided on elaborate workstations. Graphic display terminals and input devices are discussed in the forthcoming sections. The output

devices used with the CAD systems are pen plotters, hardcopy units and electrostatic plotters.

A geometric modeling is defined as the complete representation of an object that includes in both graphical and non-graphical information. In computer-aided design, geometric modeling is concerned with the computer compatible mathematical description of the geometry of an object. The mathematical description of the geometry of an object to be displayed and manipulated on a graphics terminal through signal from CPU of the CAD system. The software that provides geometric modeling capabilities must be designed for efficient use of both by the computer and the human designer.

To use geometric modeling, the designer construct the graphical image of the object on the CRT screen of the IGS system by inputting three types of commands to the computer. The first type of command generates basic geometric elements such as points, lines, and circles. The second command types is used to accomplish scaling, rotation or other transformations of these elements. The third type of command causes the various elements to be joined into desired shape of the object being created on the ICG system.

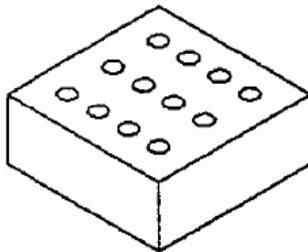
During this geometric modeling process the computer converts the commands into mathematical model, stores it in the computer data files and displays it as an image on the screen. The model can be subsequently being called from the data files for review, analysis or alteration. The most advanced method of geometric modeling is solid modeling in three dimensions. This method uses solid geometry shapes called primitives to construct the object.

Basically there are three types of modeling, they are

- a. Wire Frame Modeling**
- b. Surface Modeling**
- c. Solid Modeling**

WIRE FRAME MODEL-INTRODUCTION:

This is the basic form of modeling; here the objects drawn will be simple but more verbose, geometric model that can be used to represent it mathematically in the computer. It is sometimes referred as a stick figure or an edge representation of the object. Typical CAD/CAM system provides users with possibly three modes to input coordinates: Cartesian, Cylindrical or Spherical. Each mode has explicit or implicit inputs. Explicit input could be absolute or incremental coordinates. Implicit input involves user digitizes..A wire frame model consists of points, lines, arcs, circles & curves. Early wire frame modeling techniques developed in 1960's were 2-dimensional. They are not centralized & associative. Later in 1970's the centralized, associative database concepts enabled modeling of 3D objects as wire frame models that can be subject to 3-dimensional transformations.

**WIRE FRAME ENTITIES**

Wire frame Entities are divided into 2 types are:

- a) Synthetic Entities----- Splines & Curves
- b) Analytic Entities----- Points, lines, Circles, arcs, conics, fillet, chamfer

Applications:

1. Two-dimensional drafting.
2. Numerical control tool path generation.

Advantages:

1. It is simple to construct model.
2. Less computer memory to store the object.
3. CPU time to retrieve, edit or update a wireframe model is less.
4. Does not require extensive training.

Disadvantages:

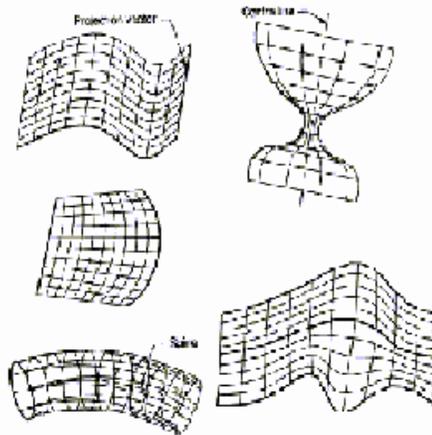
1. It is ambiguous representation of real object.

2. It lack in visual coherence and information to determine the object.
3. User or terminal time needed to prepare & or input data increases with complexity of object.
4. Inability to detect interference between components.
5. No facility for automatic shading.
6. Difficult in calculating Physical properties like Mass, surface area, centre of gravity etc.,

Surface Modeling:

A surface model of an object is more complete and less ambiguous representation than it wire frame model. It is also richer in associated geometric contents, which make it more suitable for engineering and design applications. Surface model takes one step beyond wire frame models by providing information on surfaces connecting the object edges. Creating a surface have some quantitative data such as point & tangents & some qualitative data like desired shape & smoothness. Choice of surface form depends on type of application.

3-D Surface Models



Surface Entities:

Similar to wire frame entities, existing CAD / CAM systems provide designers with both analytic and synthetic surface entities. Analytic entities include plane surface, ruled surface, surface of revolution, and tabulated cylinder. Synthetic entities include the bicubic Hermite spline surface, B – spline surface, rectangular and triangular bezier patches, rectangular and triangular Coons patches, and Gordon surface. The mathematical properties of some of these entities are covered in this chapter for two purposes. First, it

enables users to correctly choose the proper surface entity for the proper application. For example, a ruled surface is a linear surface and does not permit any twist while a B – spline surface is a general surface. Second users will be in a position to better understand CAD/CAM documentation and the related modifiers to each surface entity command available on a system. The following are descriptions of major surface entities provided by CAD/CAM systems

Advantages:.

1. Calculating mass properties.
2. Checking for interference between mating parts.
3. Generating cross-sectioned views.
4. Generating finite element mesh.

Disadvantages:

1. Surface models are generally more complex and thus require more terminal and CPU time and computer storage to create than wireframe models.
2. Surface models are sometimes awkward to create and may require unnecessary manipulations of wireframe entities.
3. It requires more training to create.
4. It does not provide any topological information.

Solid Modeling:

A solid model of an object is more complete representation than its surface model. It is unique from the surface model in topological information it stores which potentially permits functional automation and integration. Defining an object with the solid model is the easiest of the available three modeling techniques. Solid model can be quickly created without having to define individual locations as with wire frames. The completeness and unambiguity of solid models are attributed to the information that is related database of these models stores (**Topology--□ It determine the relational information between objects.**)

To model an object completely we need both geometry & topological information. Geometry is visible, whereas topological information are stored in solid model database are not visible to user. Two or more primitives can be combined to form the desire solid. Primitives are combined by Boolean Operations.

**Different Boolean operations are:**

1. Union (U)
2. Intersection (n)
3. Difference (-)

SOLID ENTITIES

There are a wide variety of primitives available commercially to users. However, the four most commonly used are the *block*, *cylinder*, *cone*, and *sphere*. These are based on the four natural quadrics: planes cylinders, cones, and spheres.

INTRODUCTION TO SOLID WORKS:

Solid Works is a powerful 3D modeling program. The models it produces can be used in a number of ways to simulate the behavior of a real part or assembly as well as checking the basic geometry. This tutorial guides you through construction of the model steam engine shown here. First you'll learn the basics of creating solid features needed to build the major functional parts and assemble them. In later sessions you'll generate engineering drawings and experiment with animation and 'photo-realistic' rendered views too. This should give you the knowledge needed to create more complex designs as you explore the enormous functionality of Solid Works.

STARTING A NEW SESSION OF Solid Works 2006:

To start a new session of Solid Works 2006, choose

Start > Programs > Solid Works 2006SP0.0 > Solid Works 2006 SP0.0 from the **Start**

menu or double-click on the **SolidWorks2006 SP0.0** icon placed on the desktop of your computer.

The Solid Works 2006 window will be displayed. If you are starting Solid Works application for the first time after installing it, the **Welcome to Solid Works** dialog box will also be displayed, as shown in Figure 1.. This dialog box welcomes you to Solid Works and helps you customize Solid Works installation. The options available in this dialog box are discussed next.

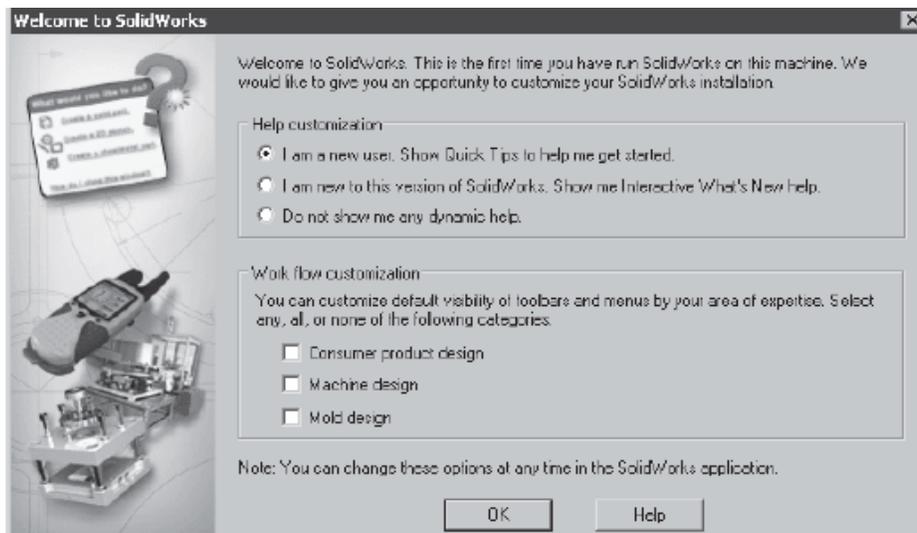


Fig 1: Solid works Welcome Window

DRAWING SKETCHES FOR SOLID MODELS:



Fig 2: Solid works 2006 Windows

STARTING A NEW DOCUMENT IN Solid Works 2006:

To start a new document in Solid Works 2006, choose the **New Document** option from the **Getting Started** group of the **Solid Works Resources Task Pane**; The **New Solid Works Document** dialog box will be displayed, as show in Figure 3. You can also invoke this dialog box by choosing the **New** button from the **Standard** toolbar. The options provided in this dialog box are discussed next.



Fig 3: Solid works Startup Dialog Box

Part

The **Part** button is chosen by default in the **New Solid Works Document** dialog box. Choose the **OK** button to start a new part document to create solid models or sheet metal components. When you start a new part document, you will enter the **Part** mode

Assembly

Choose the **Assembly** button and then the **OK** button from the **New Solid Works Document** dialog box to start a new assembly document. In an assembly document, you can assemble the components created in the part documents. You can also create components in the assembly document.

Drawing

Choose the **Drawing** button and then the **OK** button from the **New Solid Works Document** dialog box to start a new drawing document. In a drawing document, you can generate or create the drawing views of the parts created in the part documents or the assemblies created in the assembly documents.

THE SKETCHING ENVIRONMENT:

Whenever you start a new part document, by default you are in the part modeling environment. But, you need to start the design by first creating the sketch of the base feature in the sketching environment. You can invoke the sketching environment using the **Sketch** tool available in the **Standard** toolbar. You can also choose the **Sketch** button from the **Command Manager** (Figure 4) to invoke the **Sketch Command Manager**.

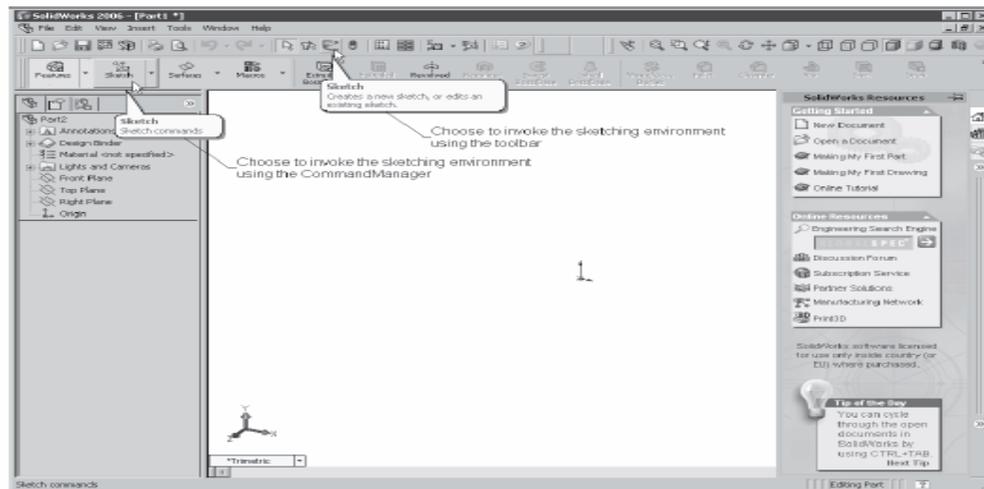


Fig: 4 Sketching Environment in Solid works

When you choose the **Sketch** button from the **Standard** toolbar or Choose any tool from the **Sketch Command Manager**; the **Edit Sketch Property Manager** is displayed and you are prompted to select the plane on which the sketch will be created. Also, the three default planes available in Solid Works 2006 (**Front Plane**, **Right Plane**, and **Top Plane**) are temporarily displayed on the screen, as shown in Figure 5.

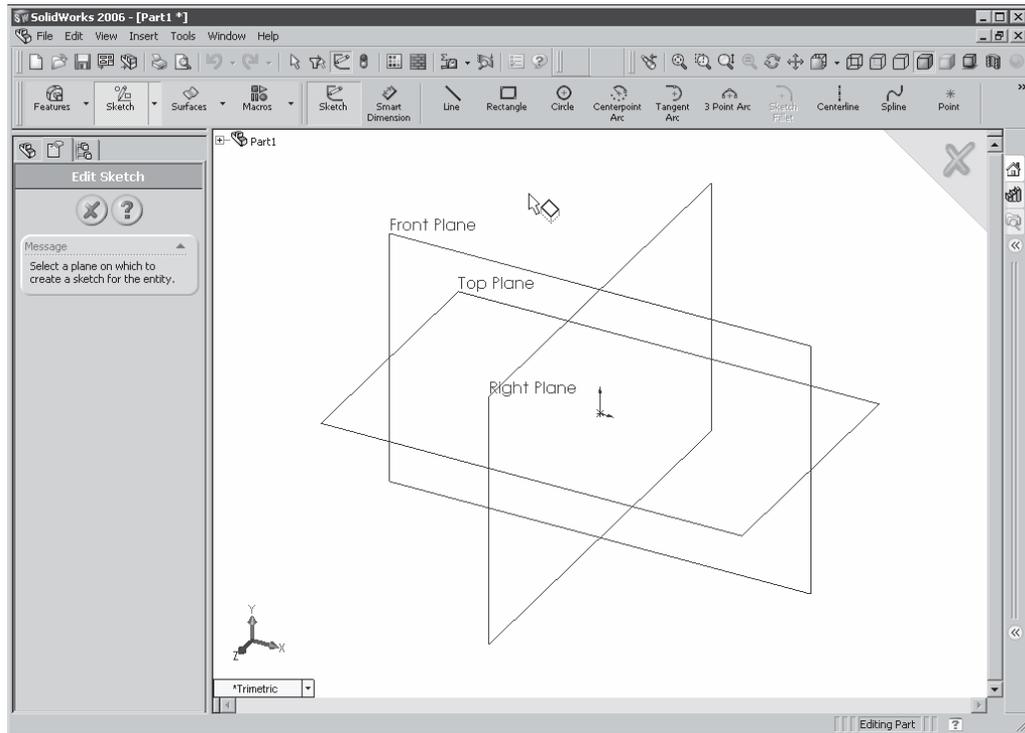


Fig 5: Planes displayed in Solid Works

EXERCISE – 1

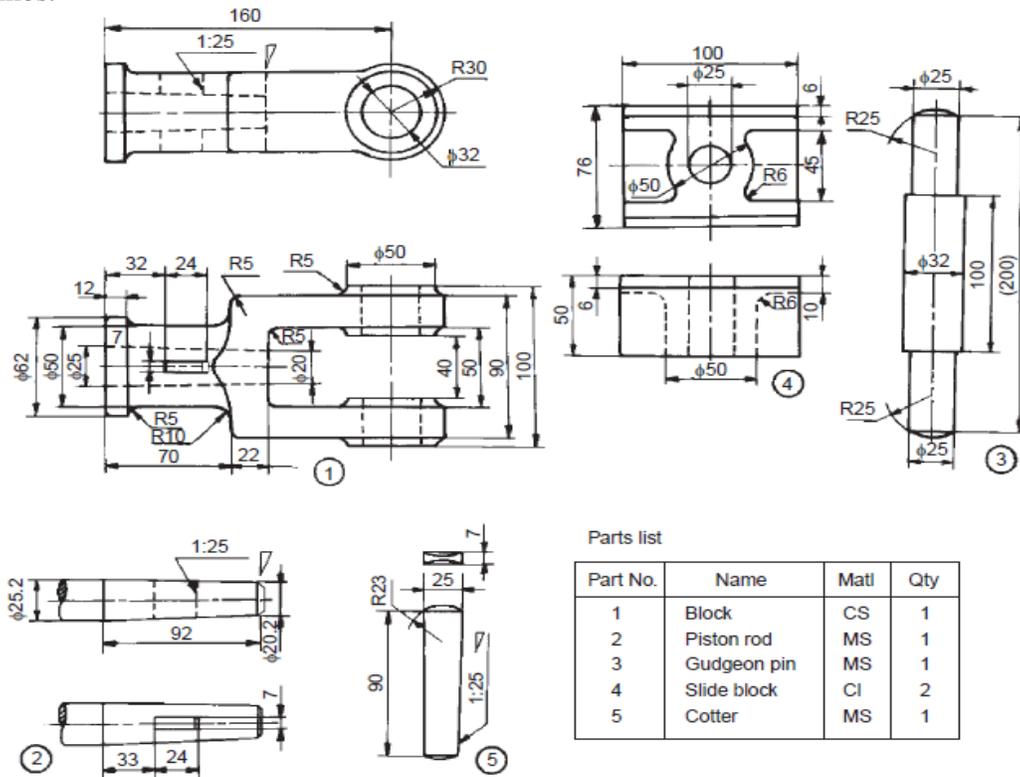
Aim: Prepare part drawing and production drawing of Steam engine cross head.

A **crosshead** is a mechanism used in large reciprocating engines and reciprocating compressors to eliminate sideways pressure on the piston.

On smaller engines the connecting rod links the piston and the crankshaft directly, but this transmits sideways forces to the piston, since the crankpin (and thus the direction the force is applied) moves from side to side with the rotary motion of the crank. These transverse forces are tolerable in a smaller engine; a larger engine's much greater forces would cause an intolerable degree of wear on the piston and cylinder, as well as increasing overall friction in the engine.

A piston rod is attached to the piston and links it to the crosshead, which is a large casting sliding in crosshead guides allowing it only to move in the same direction as the piston travel. The crosshead also houses the gudgeon pin on which the small end of the connecting rod pivots. In this way, the transverse forces are applied only to the crosshead and its bearings, not to the piston itself.

Internal combustion engines using crossheads make for easier maintenance of the top end of the engine, since the pistons can be easily removed. The piston rod is mounted on the underside of the piston and connected to the crosshead by a single nut in double acting engines.



Steam Engine Cross Head

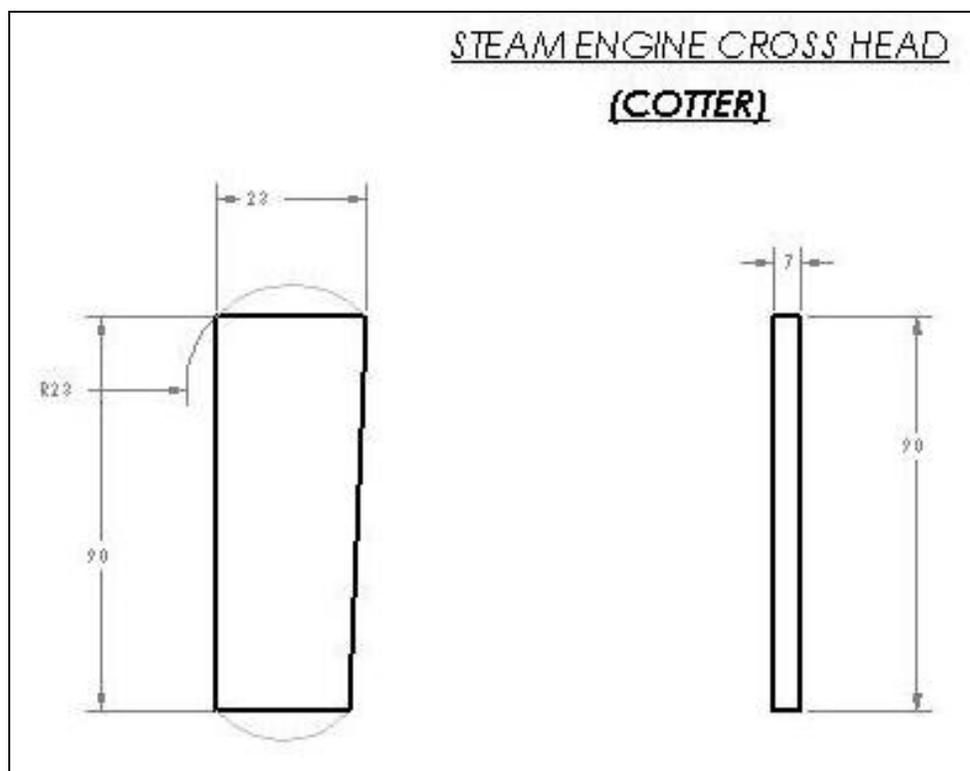
The large two-stroke marine diesel engines are usually of this pattern. The vast majority of steam engines were also built this way.

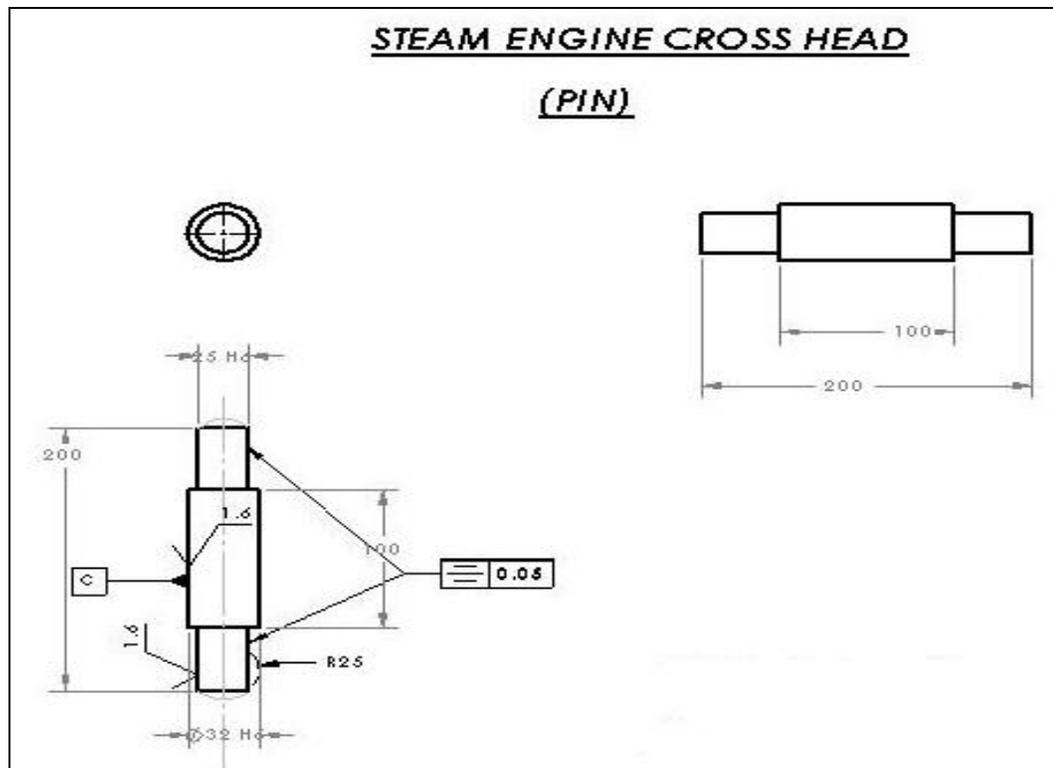
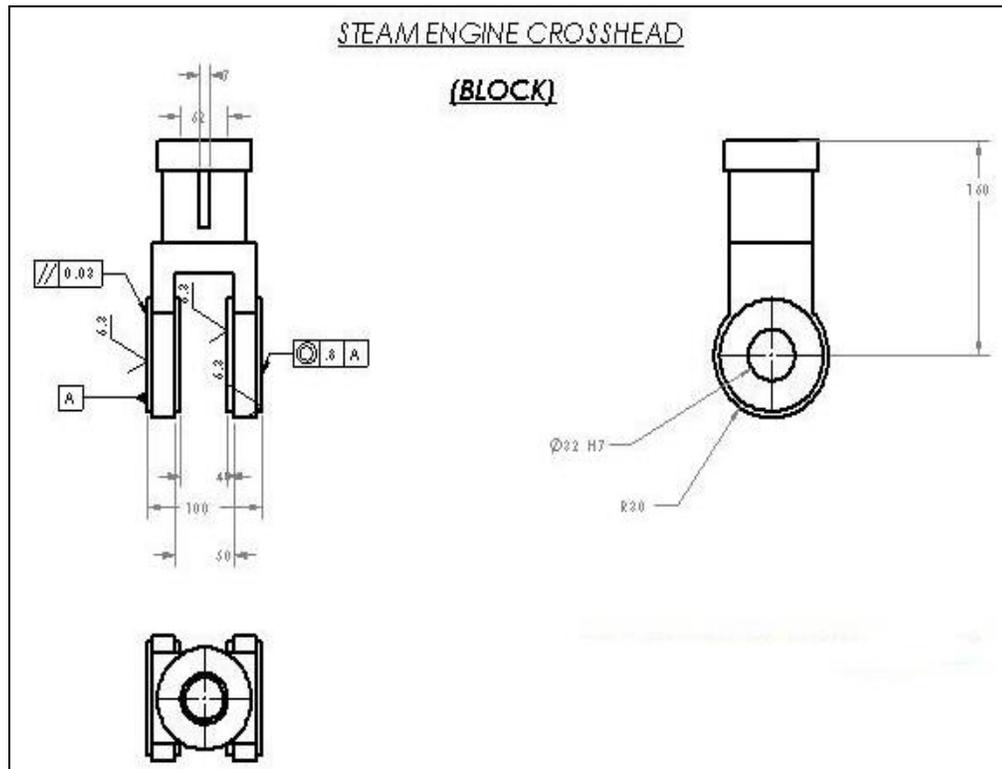
In the case of the steam engine, a crosshead is essential if the engine is to be *double acting*—steam is applied to both sides of the piston, which requires a seal around the piston rod. An exception is the oscillating cylinder steam engine which can be double acting and yet has no crosshead.

Crossheads in a steam locomotive can be mounted either to one guide mounted above the crosshead or to two, one above and one below (called an *alligator crosshead* since it has two "jaws"). The former was preferred in many modern locomotives.

Large diesels often have a plunger oil pump directly attached to the crosshead to supply oil under high pressure to the crosshead bearing.

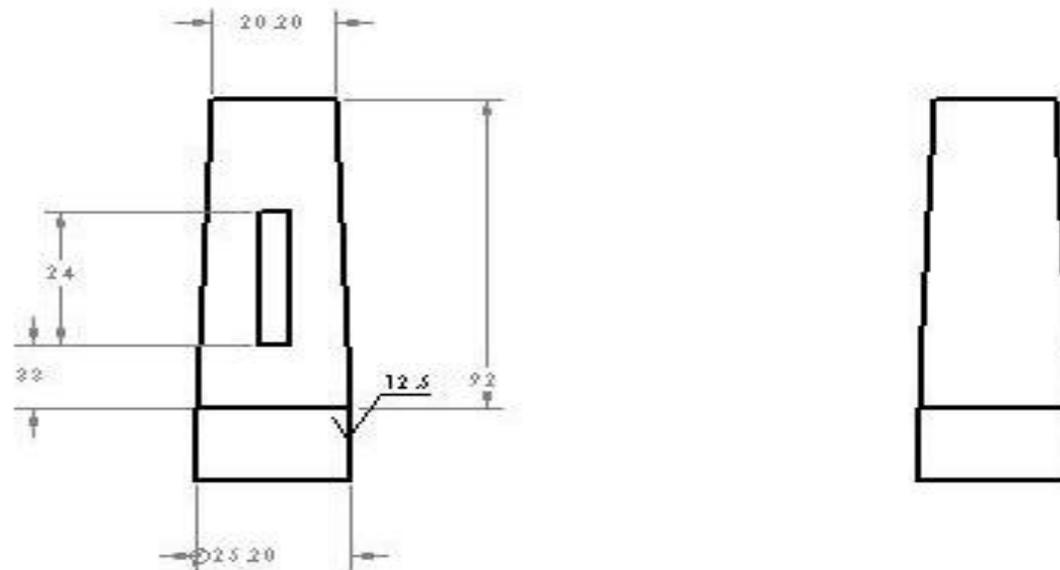
In many 19th century marine steam engines, the crosshead was a strong metal bar attached to the piston rod and perpendicular to it, which was sometimes used to eliminate transverse forces, as in a steeple engine, and at other times used as a linkage—to side-rods in a side-lever engine or to connecting rods in a square engine.





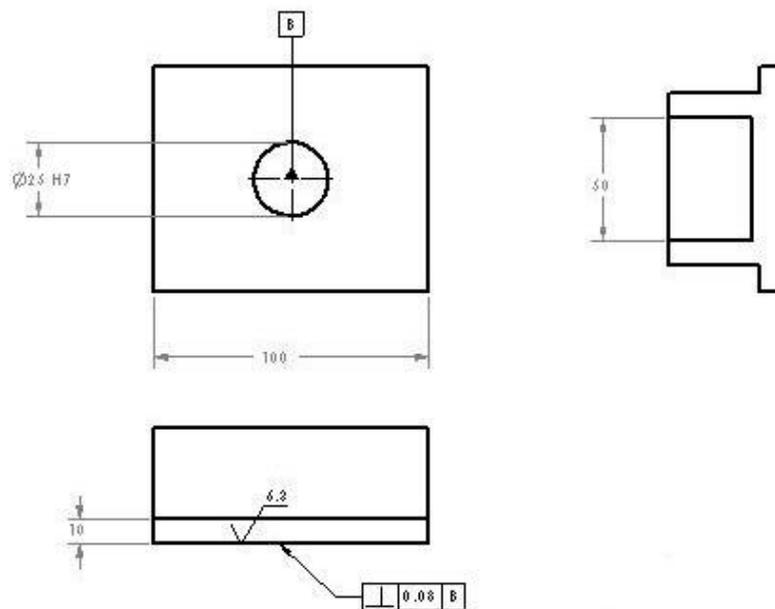
STEAM ENGINE CROSSHEAD

(PISTON ROD)



STEAM ENGINE CROSS HEAD

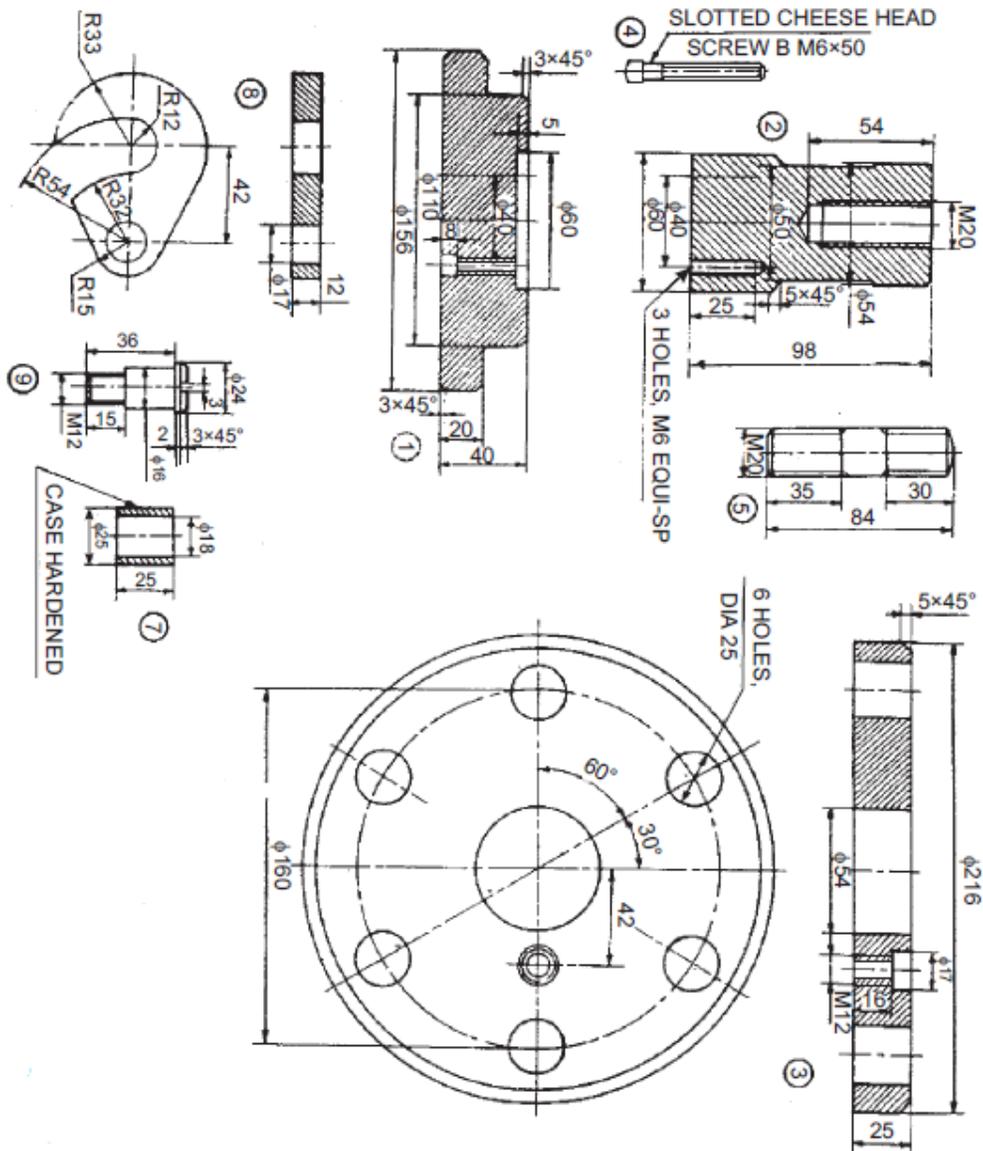
(SHOE)



EXERCISE – 2

Aim: Prepare part drawing and production drawing of drill jig

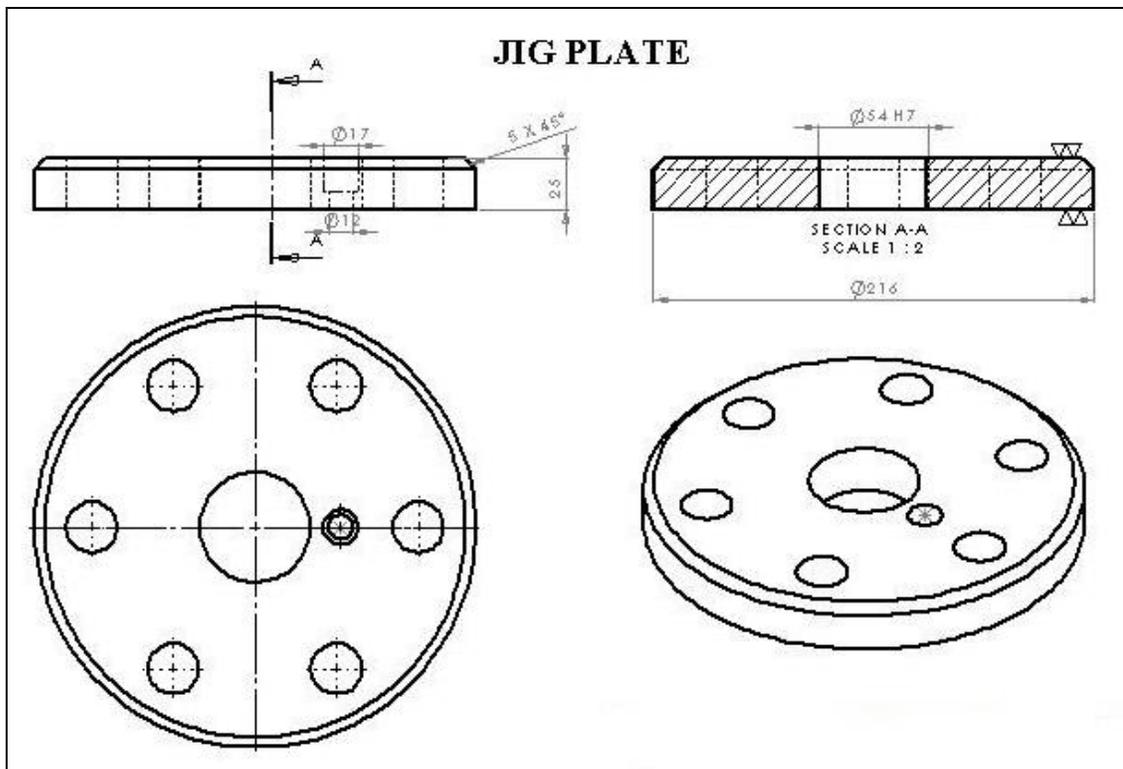
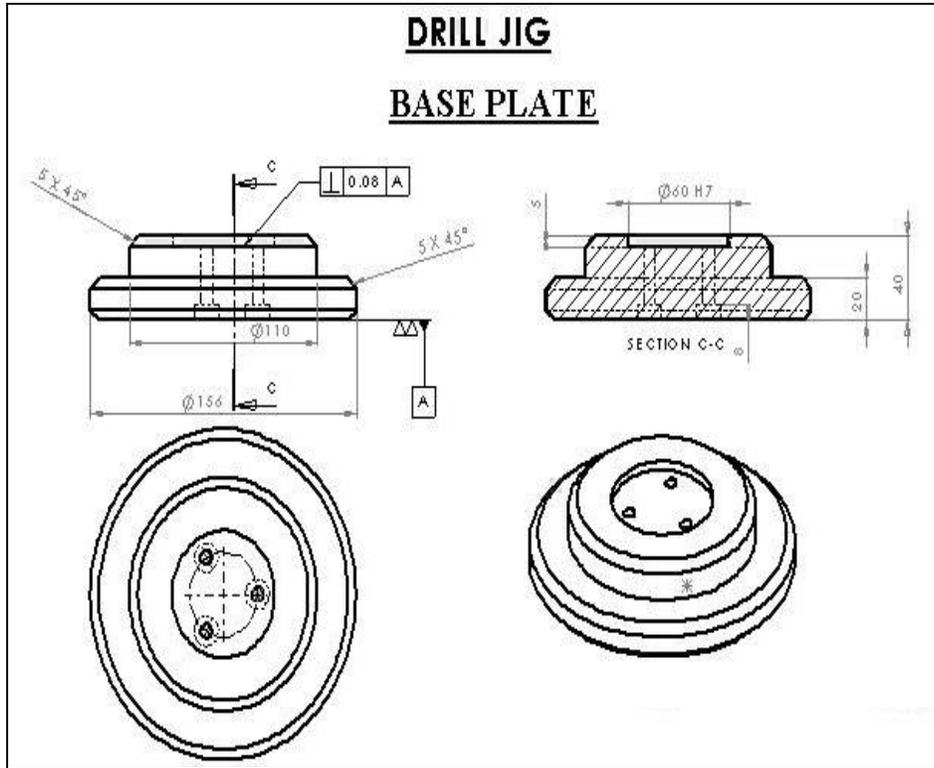
A *drill jig* is a type of jig that expedites repetitive hole center location on multiple interchangeable parts by acting as a template to guide the twist drill or other boring device into the precise location of each intended hole center. In metalworking practice, typically a hardened drill bushing lines each hole on the jig plate to keep the tool from damaging the jig.

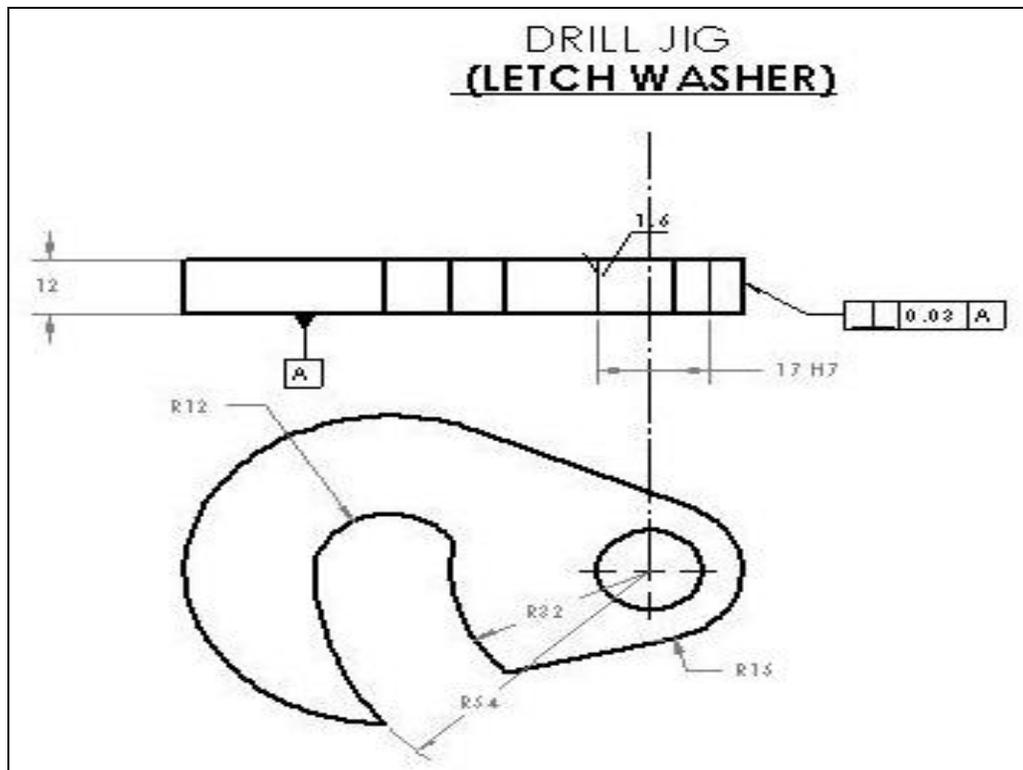
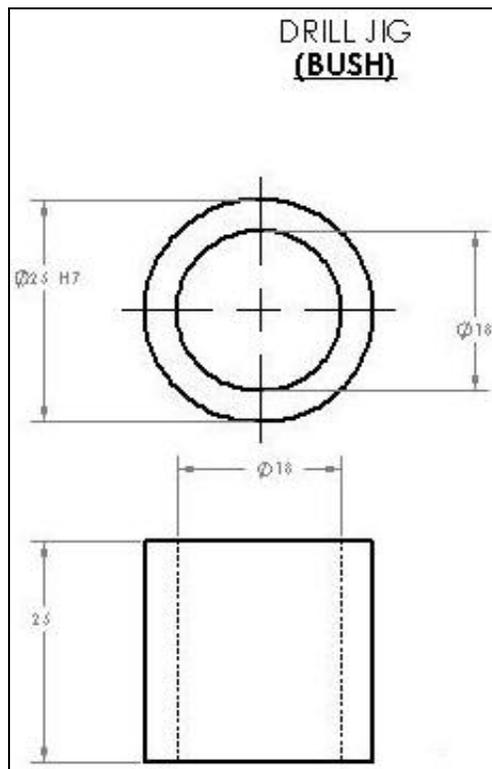


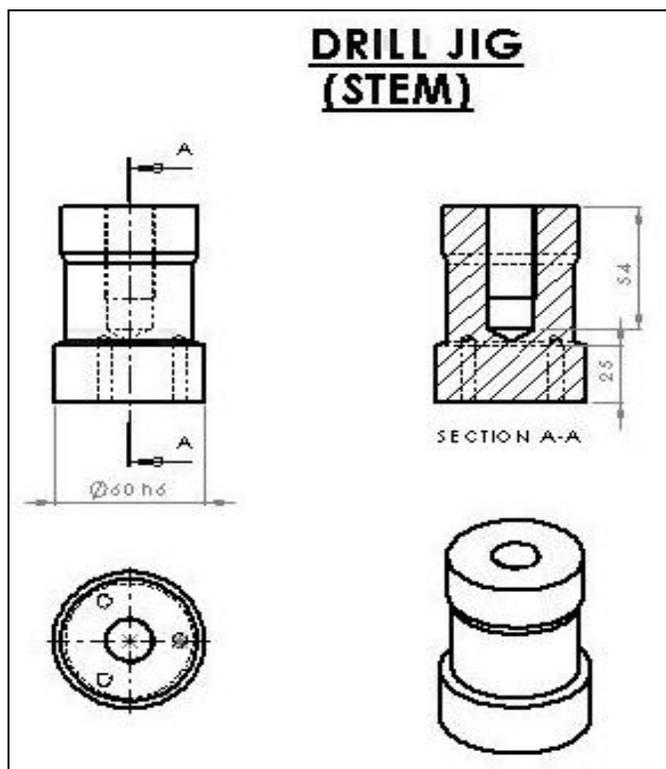
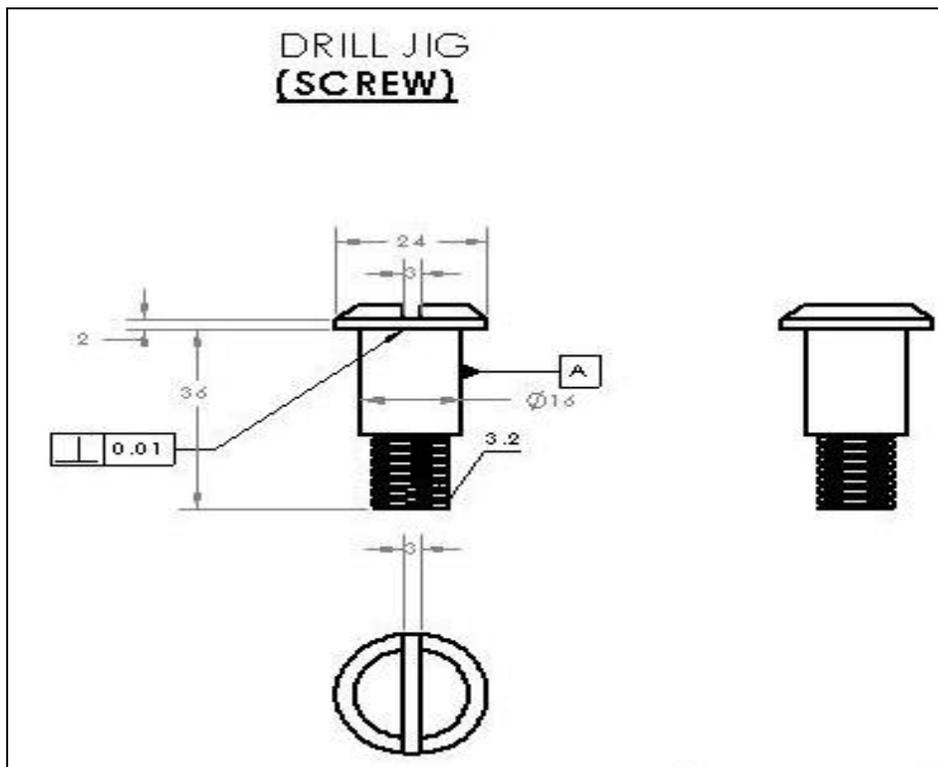
Drill Jig (Plate Type)

Drill jigs started falling into disuse with the invention of the jig borer. Since the widespread penetration of the manufacturing industry by CNC machine tools, in which servo controls are capable of moving the tool to the correct location automatically, the need for drill jigs

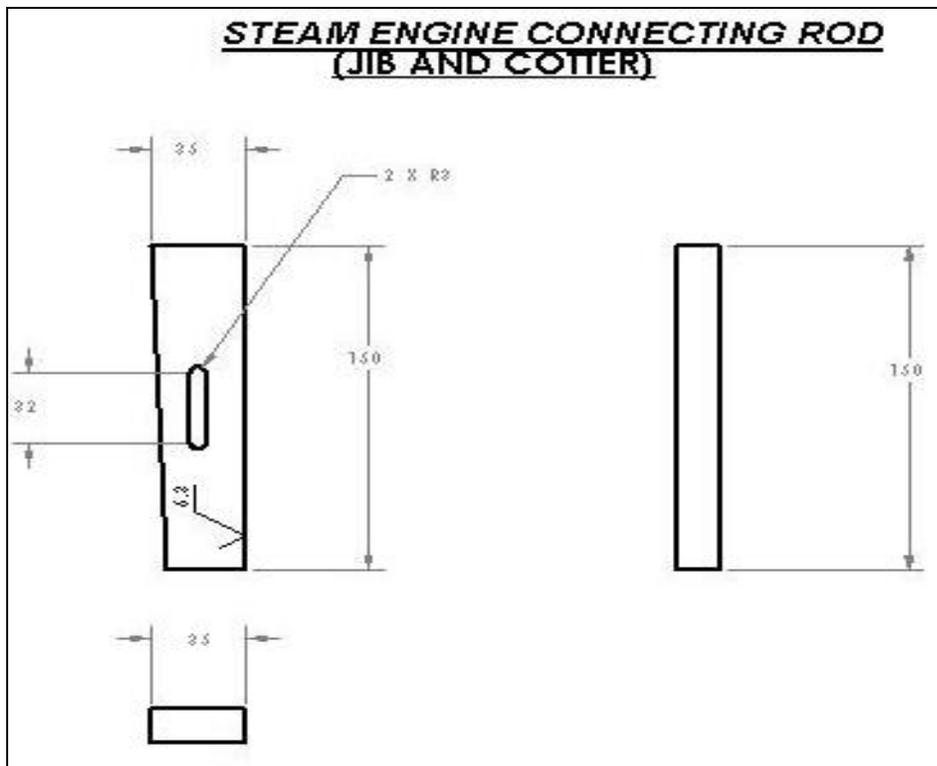
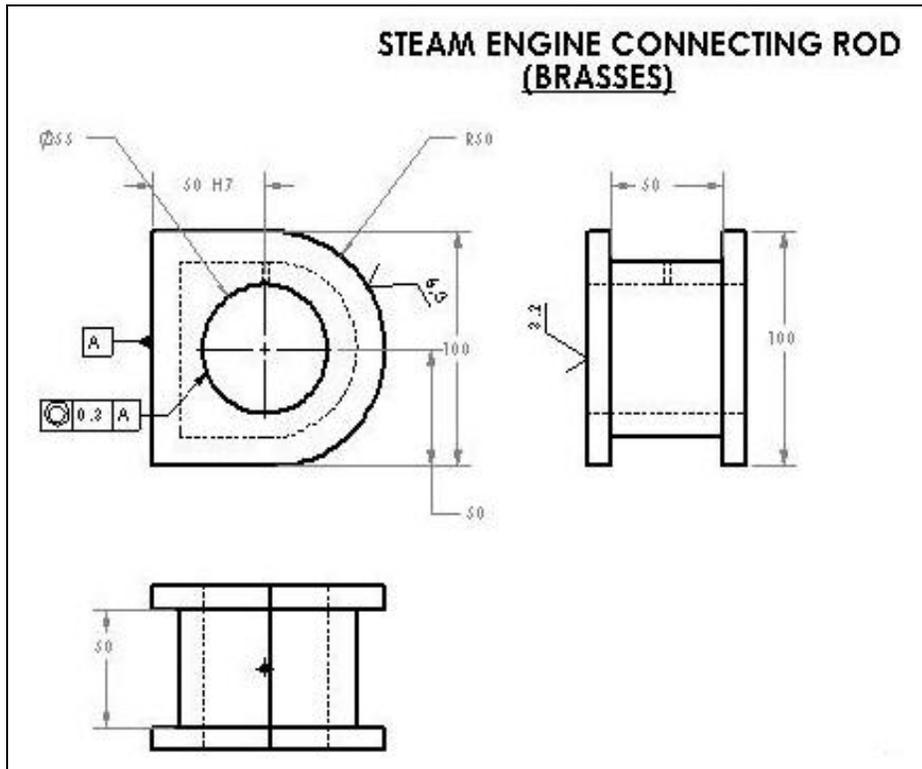
(and for the jobs of the drill press operators who used them) is much less than it previously was.

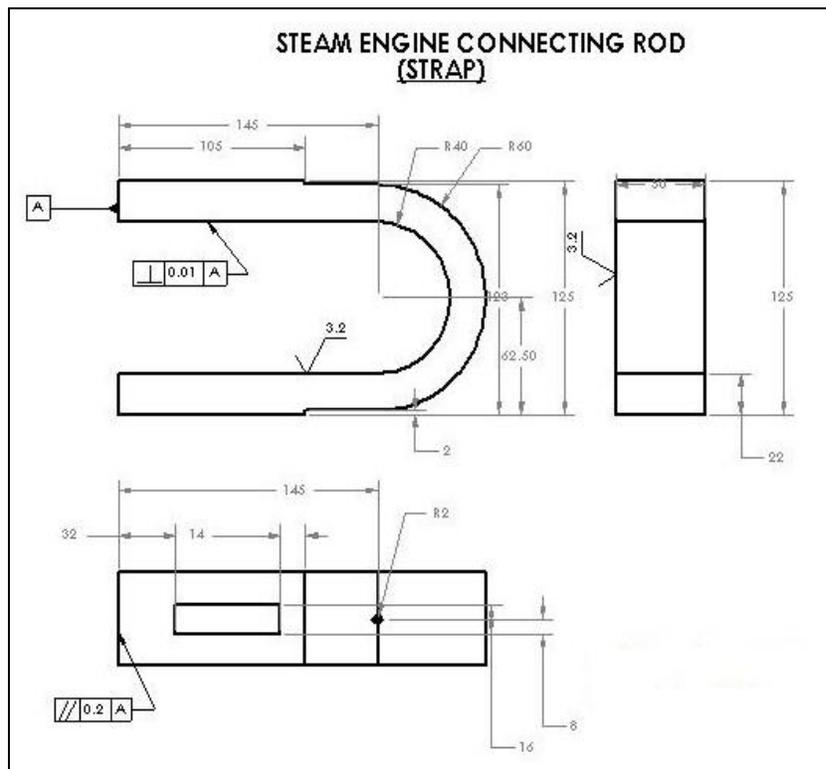
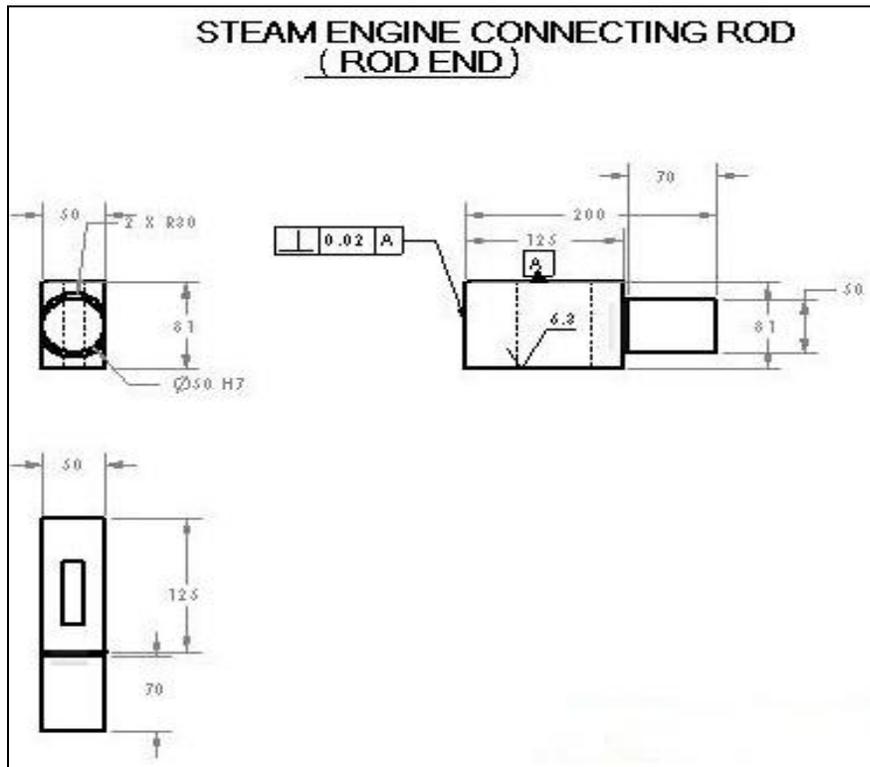






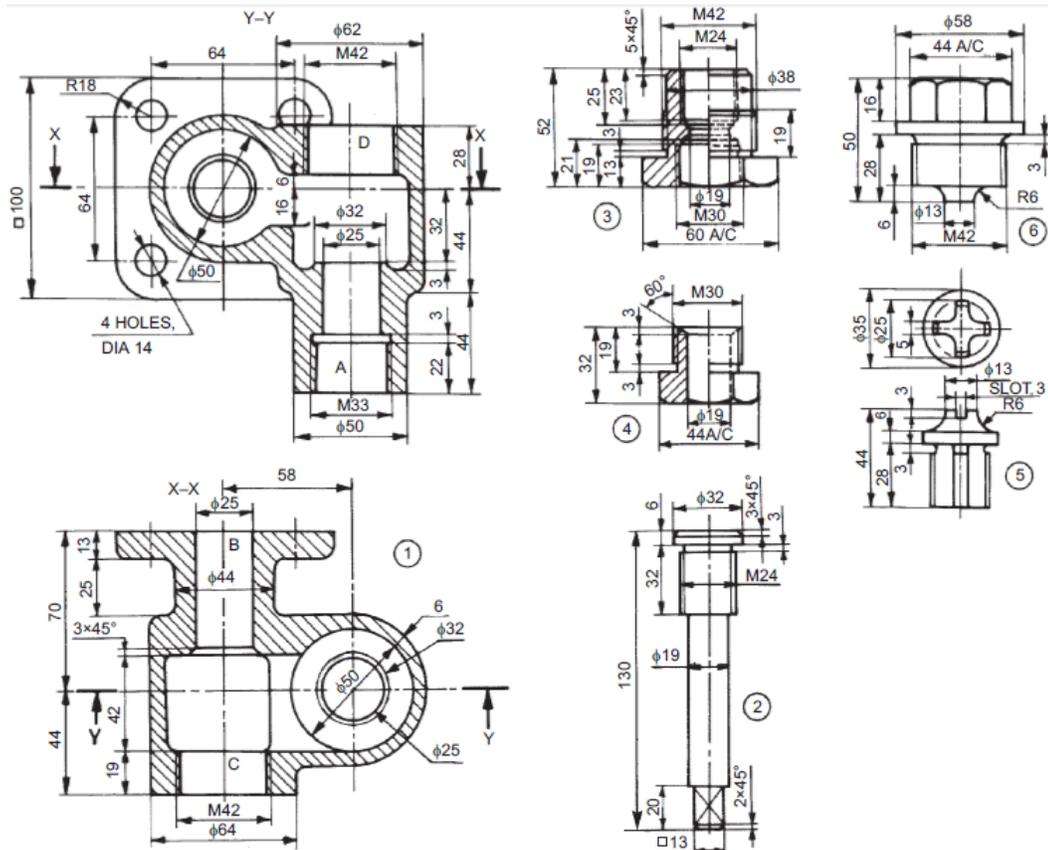
Today, connecting rods are best known through their use in internal combustion piston engines, such as automotive engines. These are of a distinctly different design from earlier forms of connecting rods, used in steam engines and steam locomotives.





EXERCISE – 4**Aim: Prepare part drawing and production drawing of Non return Valve**

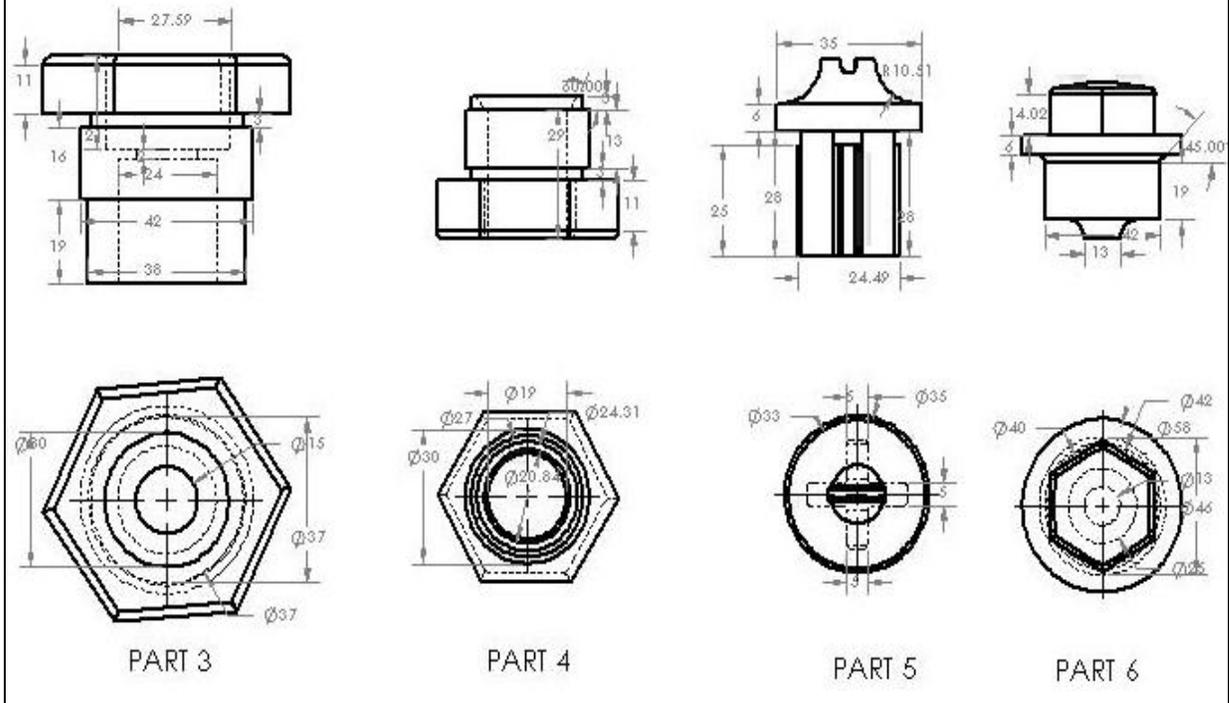
A **check valve**, **clack valve**, **non-return valve** or **one-way valve** is a valve that normally allows fluid (liquid or gas) to flow through it in only one direction. Check valves are two-port valves, meaning they have two openings in the body, one for fluid to enter and the other for fluid to leave. There are various types of check valves used in a wide variety of applications. Check valves are often part of common household items. Although they are available in a wide range of sizes and costs, check valves generally are very small, simple, or inexpensive. Check valves work automatically and most are not controlled by a person or any external control; accordingly, most do not have any valve handle or stem. The bodies (external shells) of most check valves are made of plastic or metal.

**Non Return Valve**

An important concept in check valves is the cracking pressure which is the minimum upstream pressure at which the valve will operate. Typically the check valve is designed for and can therefore be specified for a specific cracking pressure.

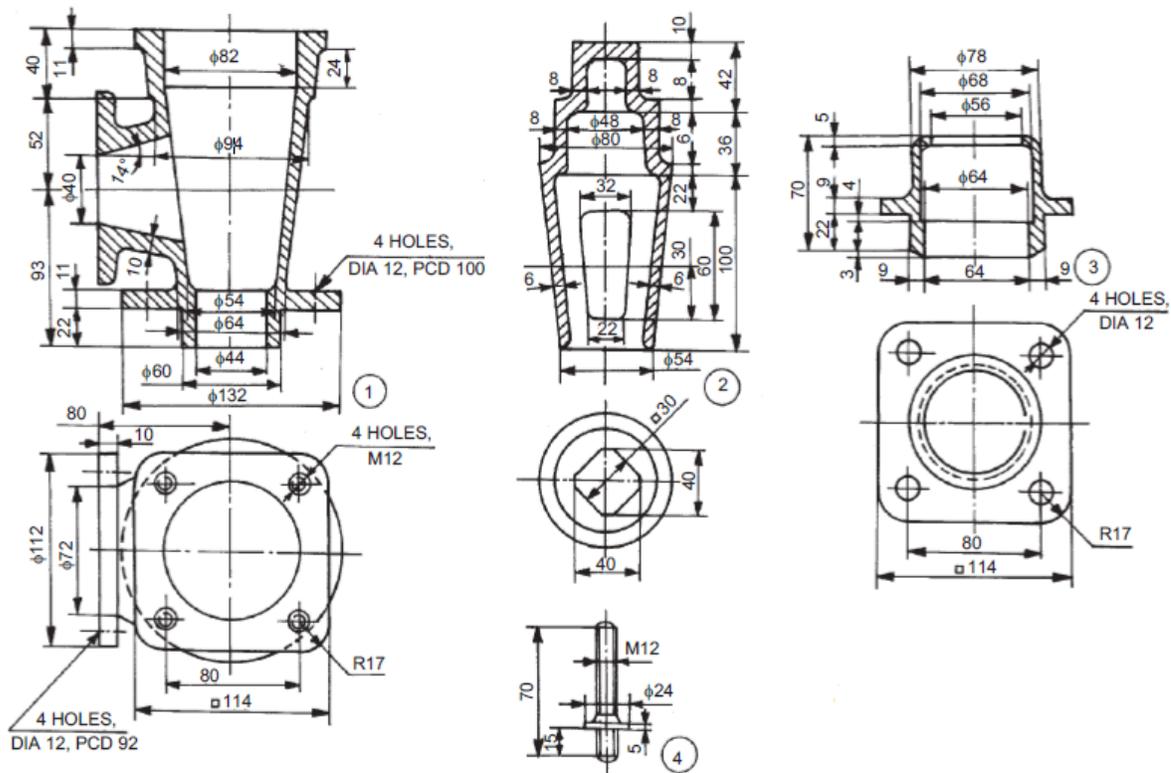
Check valves are often used with some types of pumps. Piston-driven and diaphragm pumps such as metering pumps and pumps for chromatography commonly use inlet and outlet ball check valves. These valves often look like small cylinders attached to the pump

NON RETURN VALVE



EXERCISE – 5**Aim: Prepare part drawing and production drawing of blow off cock**

The blow-off cock is fitted at the lowest part of the boiler, to remove the sediments collected. When operated, water and sediments rush through the side flange of the cock (due to pressure in the boiler) and escape through the bottom flange. Figure shows the parts of a blow-off cock. It consists of a hollow conical body 1 into which the cock 2 is located. Both the cock and body have vertical slots and when they are aligned, water gushes through the cock. Gland 3 is fastened to the body by means of studs 4. To prevent leakage, packing material is placed between the cock and gland. Figure shows the assembly drawing of the blow-off cock.

**Blow off Cock**

