CAD/CAM LABORATORY MANUAL

MECHANICAL ENGINEERING DEPARTMENT

(ISO 9001:2008 Certified)

MES COLLEGE OF ENGINEERING, KUTTIPPURAM

CAD/CAM

Laboratory Manual

MECHANICAL ENGINEERING DEPARTMENT

Revision	Date	Prepared by			Approved by		
		Name	Designation	Signature	Name	Designation	Signature
Rev1.0					Dr.Rahmathunza. I	Prof. & HoD ME Dept.	

VISION

To develop the Department into a premier destination of international level for advanced learning in Mechanical Engineering and to mould quality engineers to serve the society through creative solutions.

MISSION

- To mould engineers who would be able to apply the basic science and mathematics with confidence in professional activities for the benefit of all.
- To make our graduates experts in practical problem solving with abstract thinking skills.
- To make our students life-long learners capable of building their careers upon a solid foundation of knowledge and competent in communicating technical materials and concepts in individual group situations

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

After 3-4 years of graduation, our students will be able to

- Demonstrate their skills in technical profession and/or higher education by using the acquired knowledge in Mathematics, Science and Engineering fundamentals.
- Analyze the real life problems and propose sustainable design solutions for specific needs through applications of Engineering principles.
- Recognize the ethical responsibility as engineers and judiciously serve their peers, employers & society for the benefit of all.
- Practice life-long learning by continuing up gradation of possessed skills.

PROGRAM SPECIFIC OUTCOMES (PSOs)

At the end of four year programme the students (graduates) will be able to:

- Demonstrate basic knowledge in mathematics, science and engineering.
- Design, manufacture and analyze a Mechanical system using modern engineering software tools and measurement systems.
- Cognize concepts involved in thermal and fluid energy systems.
- Utilize self education to develop lifelong learning to appraise and adapt global and societal contexts to propose Engineering solutions.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analy**sis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

TABLE OF CONTENTS

Course Outcomes (CO's)

Course Outcomes (COs)

ME 332 COMPUTER AIDED DESIGN AND ANALYSIS LAB (C318)	
C318.1	Able to perceive working knowledge in Computer Aided Design methods and procedures.
C318.2	Able to construct solid modeling using 3D modeling standard software.
C318.3	Able to solve simple structural, heat and fluid flow problems using standard FEA software

Computer aided design and computer aided engineering

Introduction

In engineering practice CAD/CAM has been utilized in different ways by different people. Some utilize it to produce drawing and document design. Other may employ it as a visual tool by generating shaded images and animated display. A third group may perform engineering analysis of some sort of geometric models such as finite element analysis. A fourth group may use it to perform process planning and generate NC part programs. In order to establish the scope and definition of CAD/CAM in an engineering environment and identify existing and future related tools , a study of a typical product cycle is necessary.

Computer aided design and computer aided engineering

Computer aided design involves the use of computer to create design drawing and product models. Computer aided design usually associated with interactive computer graphics. Computer aided design systems are powerful tools and are used in the mechanical design and geometric modeling of products and components.

Computer aided engineering simplifies the creation of the data base, by allowing several applications to share the information in the data base. This application includes,

a) Finite element analysis of stresses, strains, deflections and temperature distribution in structures and load bearing members
b) The generation , storage and retrieval of NC data
c) The design of integrated circuits and other electronic devices.

When using a CAD system the designer can conceptualize the object to be designed more easily on the graphic screen and can consider alternative designs or modify a particular design quickly to meet the necessary design requirements or changes. The designer can then subject the design to a variety of engineering analysis and can identify potential problems.

The cad systems quickly and accurately produce the definition models for products and their components. One of the outputs of this system is the generation of working drawings, which generally have higher quality and better consistency than those produced by traditional manual drafting.

Exchange specification

Because of the availability of wide variety of CAD systems with different characteristics supplied by different vendors, proper communication and exchange of data between these systems has become a significant problem. Currently for a single neutral format for better compatibility is filled mainly by the initial graphics exchange specification (IGES) ,vendors need only provide translators for their own systems, to preprocess the data in to the neutral format and to post process from the neutral format in to their system. IGES is used for translation in two directions and is also used widely for translation of 3D line and surface data.

A more recent development is solid model based standard, called product data exchange specification (PDES), which is based on IGES. Although IGES is adequate for most requirements, PDES requires less memory size and less time for execution and it is less prone to error.

Elements of CAD system

The design process in a CAD SYSTEM consist of the four stages

1) **GEOMETIC MODELLING**

In geometric modeling, a physical object is described mathematically or analytically. The designer first construct a geometrical model by giving commands that create or modify lines, surface, solids, dimensions and text that together are an accurate and complete two or three dimensional representation of the object.

The result of these commands are displayed they can be moved around on the screen and any section desired can be magnified to view details. These data are digital and are stored in the database contained in computer memory.

These models can be presented in three different ways

a) In line representation (wire frame) all edges of the model are visible as solid lines. This image can be ambiguous particularly for complex shapes. So various colors are generally used for different parts of the objects to make the object easier to visualize.
b) In the surface model all visible surfaces are shown in the model
c) In the solid model all surface are shown but the data describe the interior volume. Solid models can be constructed from swept volume or by the techniques.

In constructive solid geometry (CGS) simple shapes such as spheres, cubes, cylinders and cones are combined to develop a solid model.

Programs are available whereby the user selects any combination of these primitives and their sizes and combines them in to the desired solid model. Although solid models have certain advantages (such as ease of design analysis and ease of preparation for manufacturing the part) they require more computer memory and processing time than the wire frame and surface models.

2) **DESIGN ANALYSIS AND OPTIMIZATION**

After the geometric features of a particular design have been determined the design is subjected to engineering analysis. This phase may consist of analyzing, for example stress, strain deflection, vibration, heat transfer, temperature distribution or dimensional tolerances. Various sophisticated software packages are available having the capabilities to compute these quantities accurately and rapidly.

Because of the relative ease with which such analysis can now be done, designers are increasingly willing to analyze a design more thoroughly before it moves on the production.

3) **DESIGN REVIEW AND EVALUATION**

An important design stage is review and evaluation to check for any interference between various components. This stage is done in order to avoid difficulties during assembly or use of the part and to determine whether moving members are going to operate as intended.

Software is available having animation capabilities, to identify potential problems with moving members and other dynamic situations. During the design review and evaluation stage, the part is precisely dimensioned and tolerance to the full degree required for manufacturing it.

4) **DOCUMENTATION AND DRAFTING**

After the preceding stage has been completed, the design is reproduced by automated drafting machine for documentation and reference. At this stage details and working drawings are also developed and printed. The CAD system is also capable of developing and drafting sectional views of the part, scaling the drawing and performing transformations in order to present various views of the part.

Although much of the design process in CAD systems was formerly carried out on workstations connected to main frame computer, the trend has changed rapidly to powerful, high performance and much less expensive stand alone desktop 32 bit UNIX workstations. 64 bit processor having even better performance is also available.

SOLIDWORKS

Exercise no.1

PART MODELLING

AIM

To model the given drawing according to the given dimensions

SOFTWARE USED

SOLIDWORKS 2013

PROCEDURE

1. Create a working directory.

2. Take a new file from the standard tool bar and PART module was chosen.

3. Using the appropriate feature creation tools in the part module, model the given part .mainly the following feature creation tools are used.

A) EXTRUSION

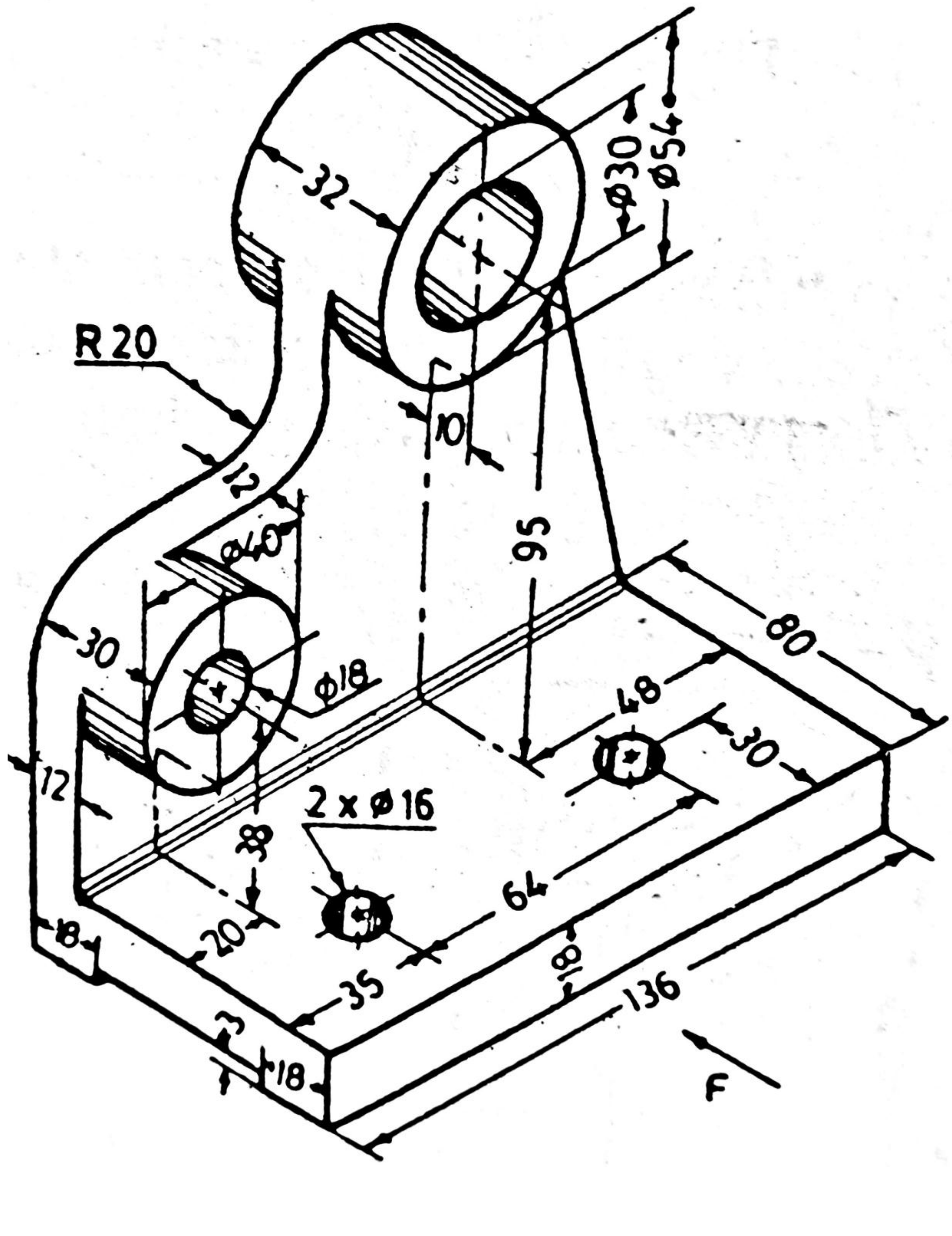
B) EXTRUDE CUT

C) REVOLVE

D) FILLET

4. Save the file

RESULT:


R 20
32
Ø30
Ø54
10
12
Ø40
95
80
30
Ø18
48
30
12
2 x Ø 16
38
64
20
18
18
35
136
3
18
F

Exercise no.2

PARTMODELLING

AIM

To model the given drawing according to the given dimensions

SOFTWARE USED

SOLIDWORKS 2013

PROCEDURE

1. Create a working directory.

2. Take a new file from the standard tool bar and PART module was chosen.

3. Using the appropriate feature creation tools in the part module, model the given part .mainly the following feature creation tools are used.

A) EXTRUSION

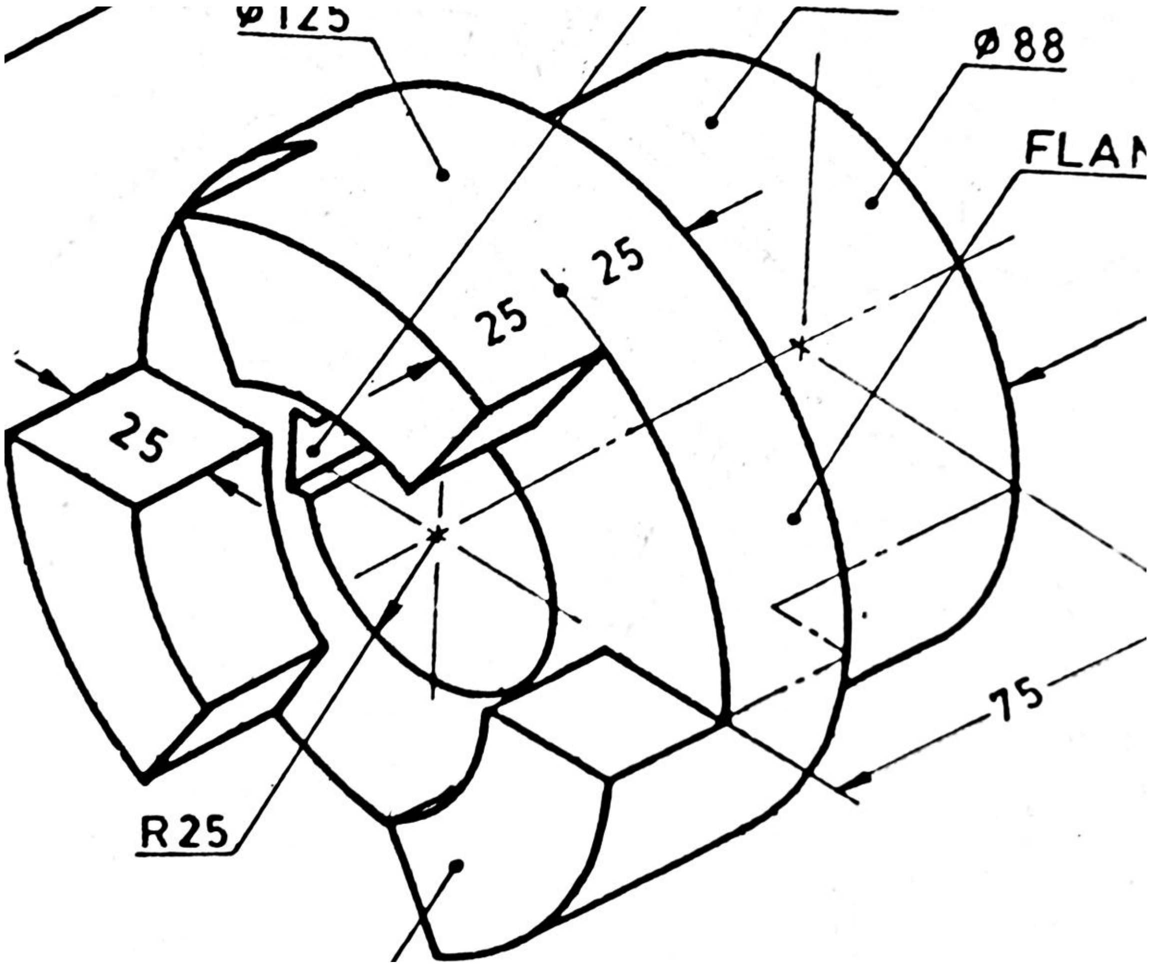
B) EXTRUDE CUT

C) REVOLVE

D) FILLET

4. Save the file

RESULT:


φ125
Ø88
FLAN
25
25
25
R25
75

Exercise no.3

PART MODELLING

AIM

To model the given drawing according to the given dimensions

SOFTWARE USED

SOLIDWORKS 2013

PROCEDURE

1. Create a working directory.

2. Take a new file from the standard tool bar and PART module was chosen.

3. Using the appropriate feature creation tools in the part module, model the given part .mainly the following feature creation tools are used.

A) EXTRUSION

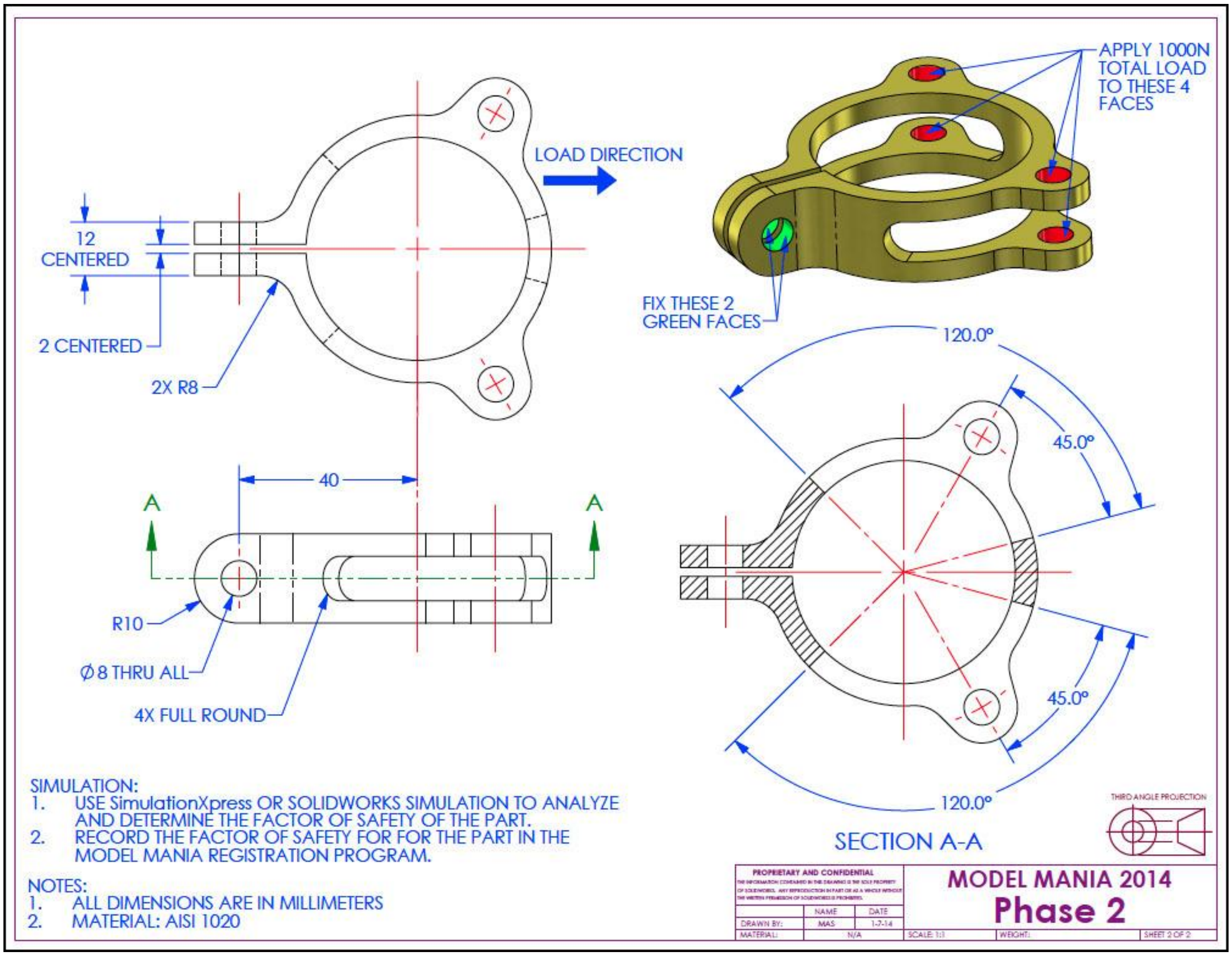
B) EXTRUDE CUT

C) REVOLVE

D) FILLET

4. Save the file

RESULT:



APPLY 1000N TOTAL LOAD TO THESE 4 FACES
LOAD DIRECTION
12 CENTERED
2 CENTERED
2X R8
FIX THESE 2 GREEN FACES
120.0°
45.0°
45.0°
120.0°
40
A
A
R10
Ø 8 THRU ALL
4X FULL ROUND
SECTION A-A
THIRD ANGLE PROJECTION
SIMULATION:
1. USE SimulationXpress OR SOLIDWORKS SIMULATION TO ANALYZE AND DETERMINE THE FACTOR OF SAFETY OF THE PART.
2. RECORD THE FACTOR OF SAFETY FOR FOR THE PART IN THE MODEL MANIA REGISTRATION PROGRAM.
NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS
2. MATERIAL: AISI 1020
PROPRIETARY AND CONFIDENTIAL
NAME
DATE
DRAWN BY:
MAS
1-7-14
MATERIAL:
N/A
SCALE: 1:1
WEIGHT:
SHEET 2 OF 2
MODEL MANIA 2014
Phase 2

Exercise no.4

ASSEMBLY MODELLING

AIM

To model the given drawing according to the given dimensions

SOFTWARE USED

SOLIDWORKS 2013

PROCEDURE

1. Create a working directory.

2. Take a new file from the standard tool bar and PART module was chosen.

3. Using the appropriate feature creation tools in the part module, model the required parts.

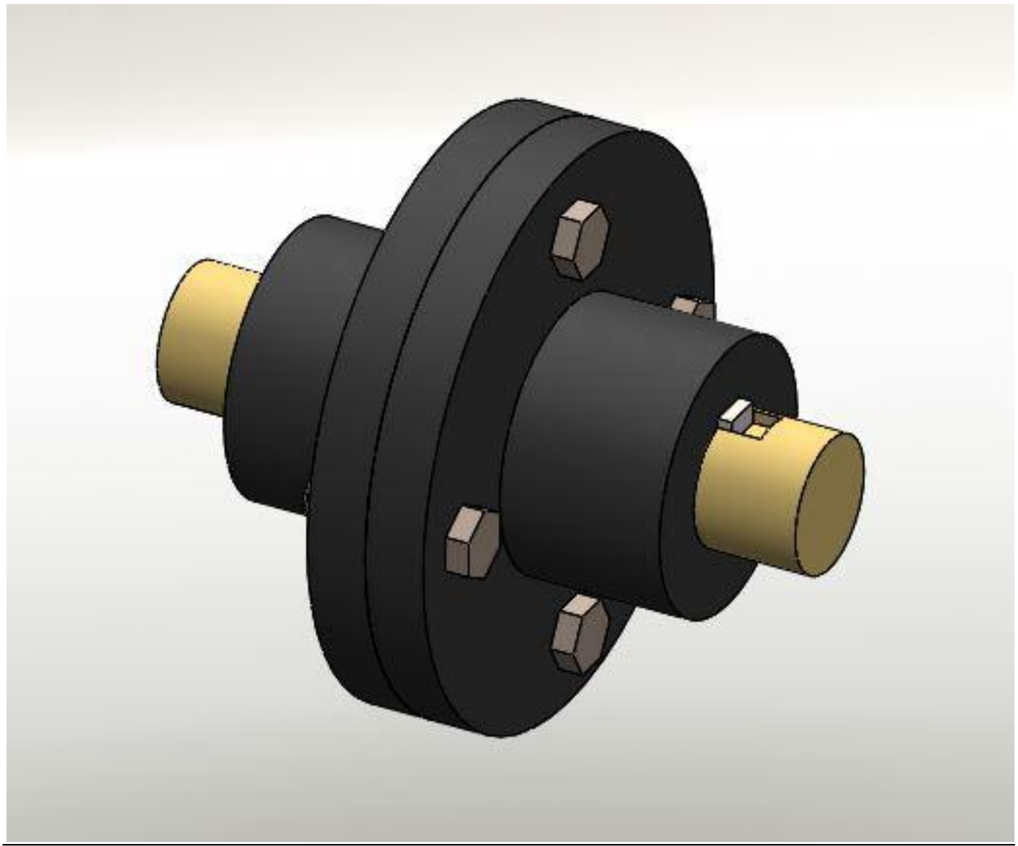
4. Take the new menu from the standard tool bar and chose ASSEMBLY Module.

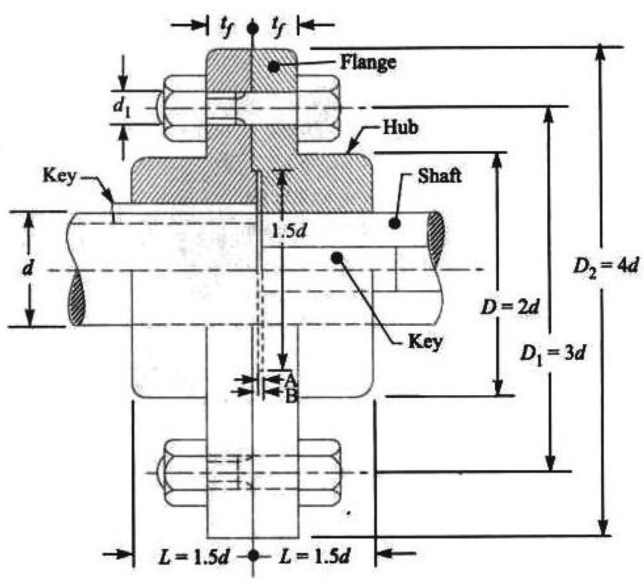
5. Add a component (PART) and make it as datum.

6. Open all other parts one by one and give the suitable constrains and connections required for the assembly using different tools in the assembly module.

7. Save the file

RESULT:





t_f
t_f
Flange
d_1
Hub
Key
Shaft
1.5d
d
$D_2 = 4d$
$D = 2d$
Key
$D_1 = 3d$
A
B
$L = 1.5d$
$L = 1.5d$

Exercise no.5

ASSEMBLY MODELLING

AIM

To model the given drawing according to the given dimensions

SOFTWARE USED

SOLIDWORKS 2013

PROCEDURE

1. Create a working directory.

2. Take a new file from the standard tool bar and PART module was chosen.

3. Using the appropriate feature creation tools in the part module, model the required parts.

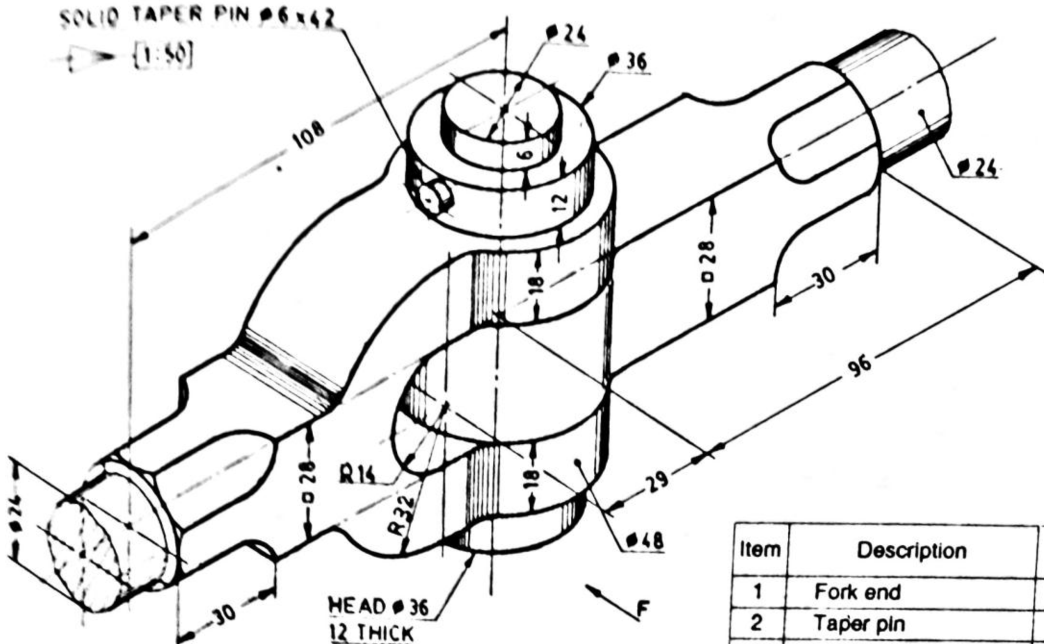
4. Take the new menu from the standard tool bar and chose ASSEMBLY Module.

5. Add a component (PART) and make it as datum.

6. Open all other parts one by one and give the suitable constrains and connections required for the assembly using different tools in the assembly module.

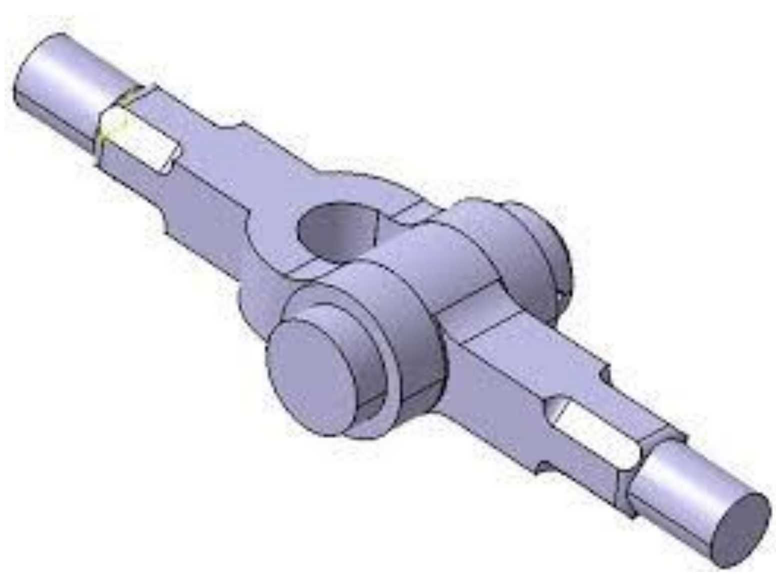
7. Save the file

RESULT:



ITEM LIST

Item	Description	Qty.	Material
1	Fork end	1	M. S.
2	Taper pin	1	M. S.
3	Collar	1	M. S.
4	Pin	1	M. S.
5	Eye end	1	M. S.



Exercise no.6

ASSEMBLY MODELLING

AIM

To model the given drawing according to the given dimensions

SOFTWARE USED

SOLIDWORKS 2013

PROCEDURE

1. Create a working directory.

2. Take a new file from the standard tool bar and PART module was chosen.

3. Using the appropriate feature creation tools in the part module, model the required parts .

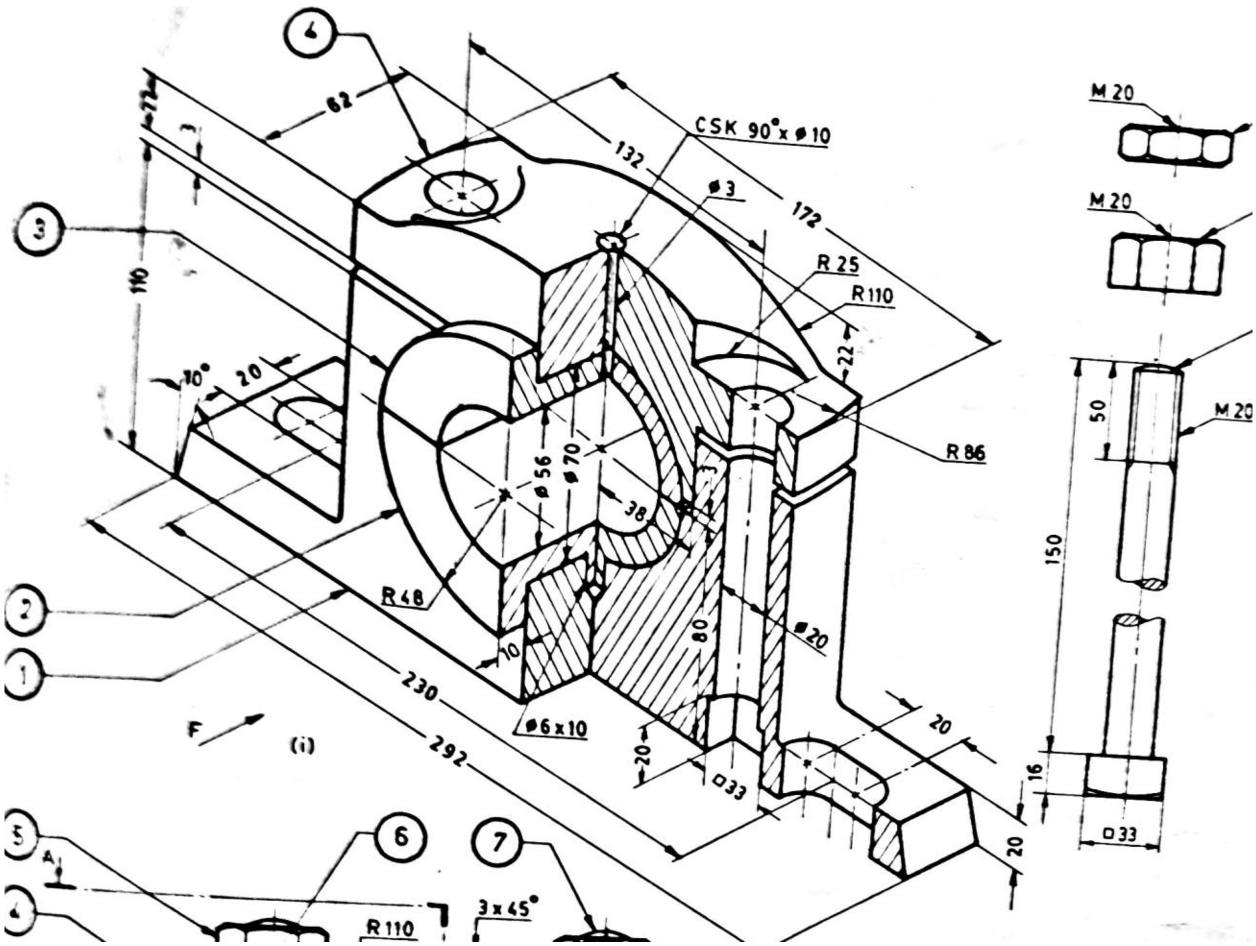
4. Take the new menu from the standard tool bar and chose ASSEMBLY Module.

5. Add a component (PART) and make it as datum.

6. Open all other parts one by one and give the suitable constrains and connections required for the assembly using different tools in the assembly module.

7. Save the file

RESULT:


CSK 90° x ø10
132
172
62
ø3
R 25
R110
22
110
10°
20
R 86
ø56
ø70
38
R48
80
ø20
10
230
ø6 x 10
292
20
□33
F
(i)
M 20
M 20
50
150
16
□33
R 110
3 x 45°
A

ANSYS

Exercise no.1

SIMULATION AND ANALYSIS OF A TRUSS

AIM

To analyze and find out the nodal displacement of the truss system shown in fig. and plot the deformed shape.

SOFTWARE USED

ANSYS 15.0

PROCEDURE

1. Create a working directory
2. From file menu take clear and start new.
3. From ANSYS main menu take preference and select displacement as structural.
4. Take preprocessor

A) Select the element type.

B) Set real constant – area

C) From material properties select the material model and select its properties as elastic and isotropic.

D) Enter the values for elastic constant and poisons ratio.

E) Select the modeling option

1) Create the key points by specifying x, y, and z.

2) Create lines between key points

F) Select meshing option and mesh appropriately.

G) Apply displacement and force constraints by selecting load option.

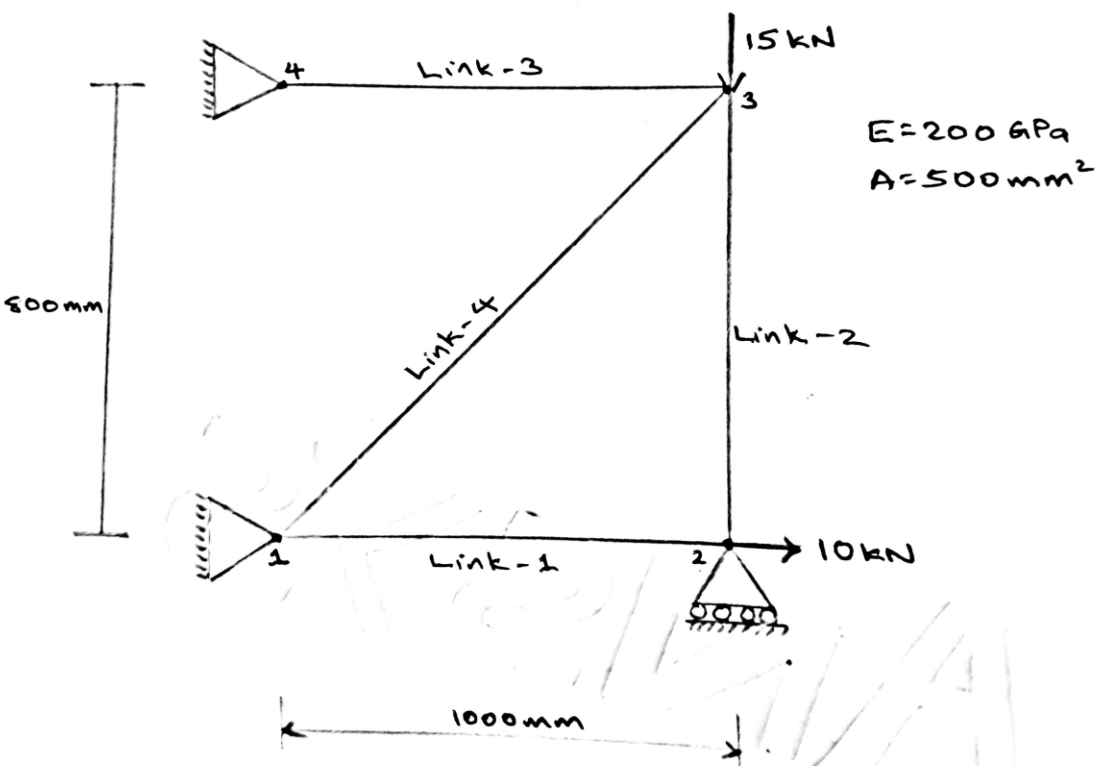
5) From solution menu select solve option to solve the problem.

6) From postprocessor menu

a) Obtain the deformed shape of the model after load application

b) Obtain the values of nodal displacements.

RESULT



<u>Exercise no.2</u>

SIMULATION AND ANALYSIS OF A CANTILEVER BEAM WITH LOAD

AIM

To analyze and find out the displacement and shear force and draw bending moment and shear force diagram.

SOFTWARE USED

ANSYS 15.0

PROBLEM DESCRIPTION

A 1000 cm cantilever beam as shown in fig. 20 N force is acting on the center of the beam

PROCEDURE

1. Create a working directory

2. From file menu take clear and start new.

3. From ANSYS main menu take preference and select displacement as structural.

4. Take preprocessor

A) Select the element type.

B) Set real constant – area

C) From material properties select the material model and select its properties as elastic and isotropic.

D) Enter the values for elastic constant and poisons ratio .

E) Select the modeling option

1) Create the key points by specifying x, y, and z.

2) Create lines between key points

F) Select meshing option and mesh appropriately.

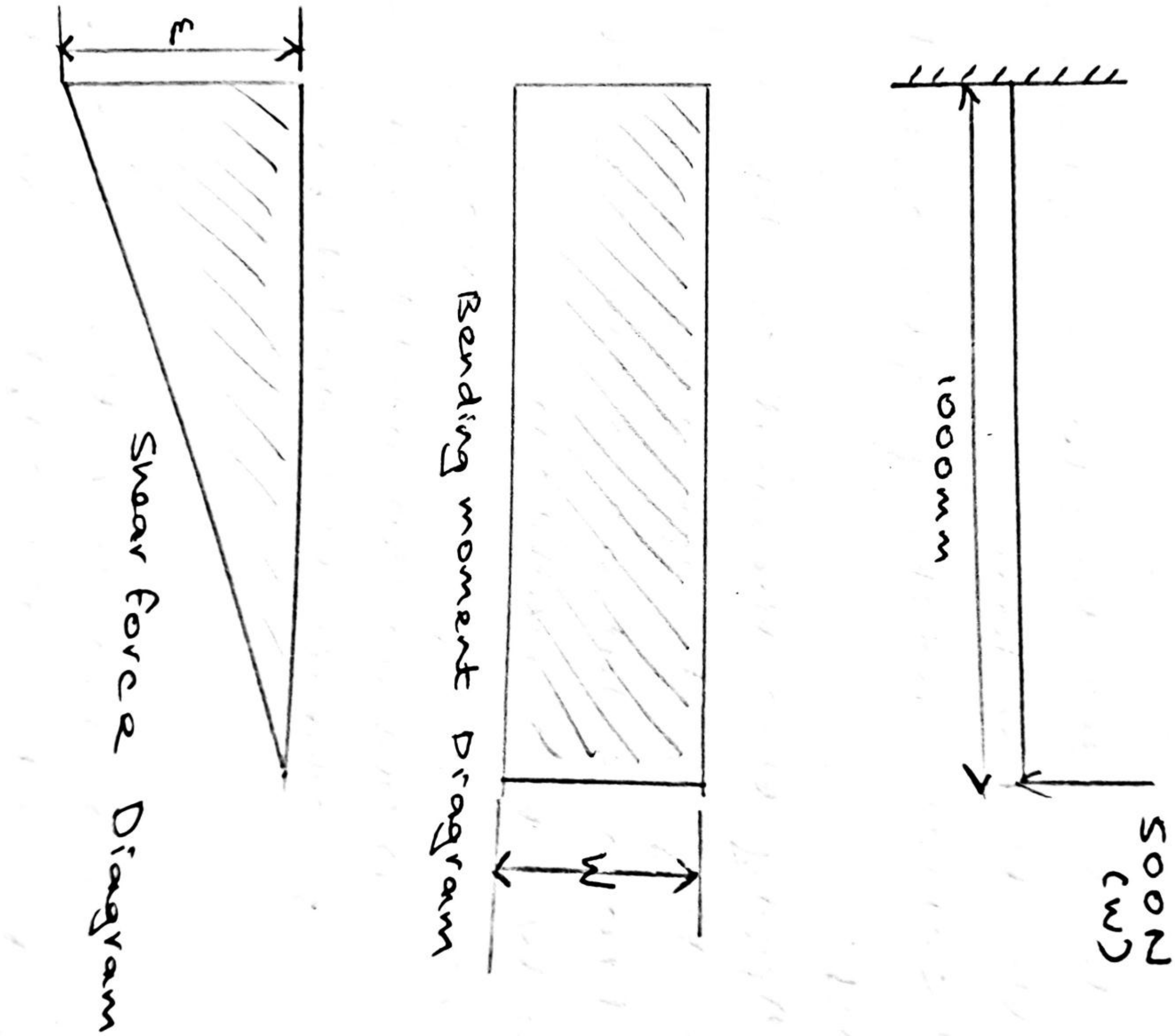
G) Apply displacement and force constraints by selecting load option.

5) From solution menu select solve option to solve the problem.

6) From postprocessor menu

a) Obtain the deformed shape of the model after load application

RESULT


Shear force Diagram
Bending moment Diagram
1000mm
500N
(W)

<u>Exercise no.3</u>

SIMULATION AND ANALYSIS OF A CANTILEVER BEAM WITH UDL

AIM

To analyze and find out the maximum bending, stress and deflection at the middle portion of the simply supported beam with uniformly distributed load on it.

SOFTWARE USED

ANSYS 15.0

PROBLEM DESCRIPTION

A standard 75 cm simply supported beam with a cross sectional area is supported and loaded on the over hanging by a uniformly distributed load.

PROCEDURE

1. Create a working directory

2. From file menu take clear and start new.

3. From ANSYS main menu take preference and select displacement as structural.

4. Take preprocessor

   a) Select the element type.

   b) Set real constant – area

c) From material properties select the material model and select its properties as elastic and isotropic.

d) Enter the values for elastic constant and poisons ratio .

e) Select the modeling option

1) Create the key points by specifying x, y, and z.

2) Create lines between key points

f) Select meshing option and mesh appropriately.

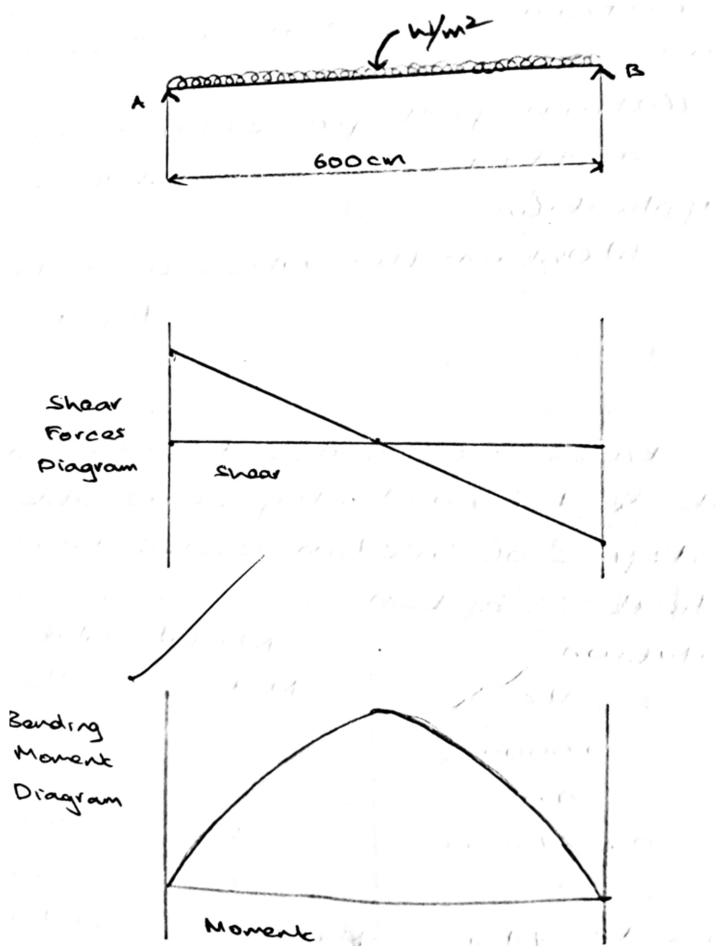
g) Apply displacement and force constraints by selecting load option.

5) From solution menu select solve option to solve the problem.

6) From postprocessor menu

a) Obtain the deformed shape of the model after load application

RESULT


w/m²
A
B
600cm
Shear
Forces
Diagram
Shear
Bending
Moment
Diagram
Moment

Exercise no.4

THERMAL ANALYSIS OF A COPPER PLATE

AIM

To analyze and find out the rate of heat transfer per unit area through a copper plate.

SOFTWARE USED

ANSYS 15.0

PROCEDURE

1. Create a working directory

2. From file menu take clear and start new.

3. From ANSYS main menu take preference and select displacement as thermal.

4. Take preprocessor

A) Select the element type.

B) Set real constant – area

C) From material properties select the material model and select its properties as thermal conductivity and isotropic.

D) Enter the values for thermal conductivity of copper

E) Select the modeling option

1) Create the key points by area with 2 corner rectangle with height and width.

F) Select meshing option and mesh appropriately.

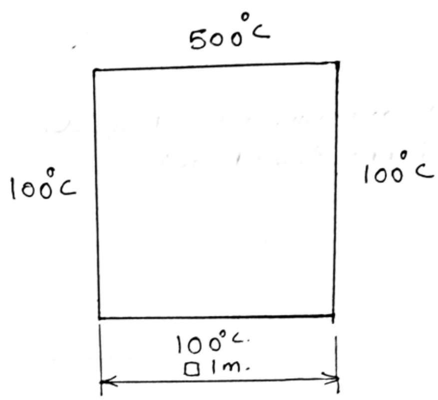
G) Apply steady state thermal condition as the load on the plate by selecting load option

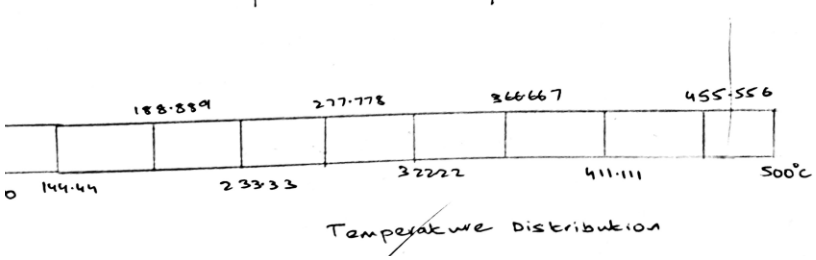
5) From solution menu select solve option to solve the problem.

6) From postprocessor menu

a) Obtain the nodal solution and nodal temperature.

RESULT





Exercise no.5

THERMAL ANALYSIS OF A PIPE

AIM

To analyze and find out the rate of heat transfer per unit length of the pipe and the temperature variation across the pipe and the insulation.

SOFTWARE USED

ANSYS 15.0

PROCEDURE

1. Create a working directory

2. From file menu take clear and start new.

3. From ANSYS main menu take preference and select displacement as thermal.

4. Take preprocessor

A) Select the element type.

B) Set real constant – area

C) From material properties select the material model and select its properties as thermal conductivity and isotropic.

D) Enter the values for thermal conductivity of copper

E) Select the modeling option

1) Create the key points by area with circle and extrude it along the normal

2) Select the Boolean option and give it along with the volume.

F) Select meshing option and mesh appropriately.

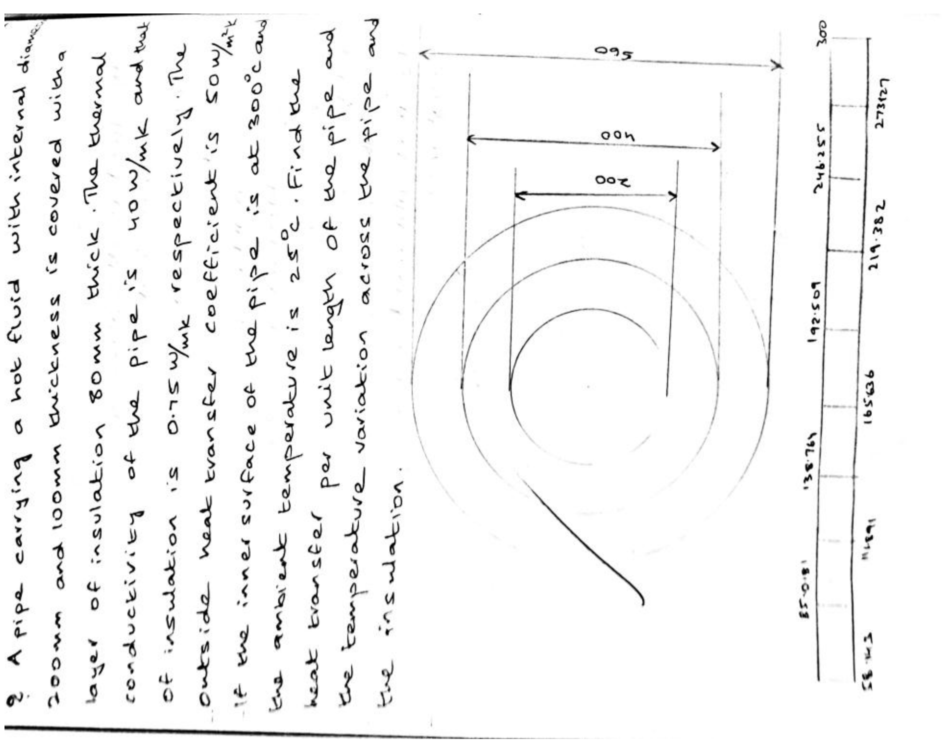
G) Apply steady state thermal condition as the load on the plate by selecting load option

5) From solution menu select solve option to solve the problem.

6) From postprocessor menu

a) Obtain the nodal solution and nodal temperature.

RESULT



<u>Exercise no.6</u>

FLUID FLOWANALYSIS THROUGH A PIPE

AIM15.0

To find out the pressure of the fluid flowing through the pipe.

SOFTWARE USED

ANSYS 15.0

PROCEDURE

ANSYS -- HELP---Vm 122 (insert)

M ℓ, DENP, 1, 8, 411 E---benzene mass density

M ℓ, MU, 1, 0.16--- Friction factor

N, 1---NODE

N, 2, 2400

E, 1, 2---ELEMENT

D, 2, PRES0—OUTLET REFERENCE PRESSURE

5I, FLOW, 121.3/386.4-- INLET MASS FLOW RATE

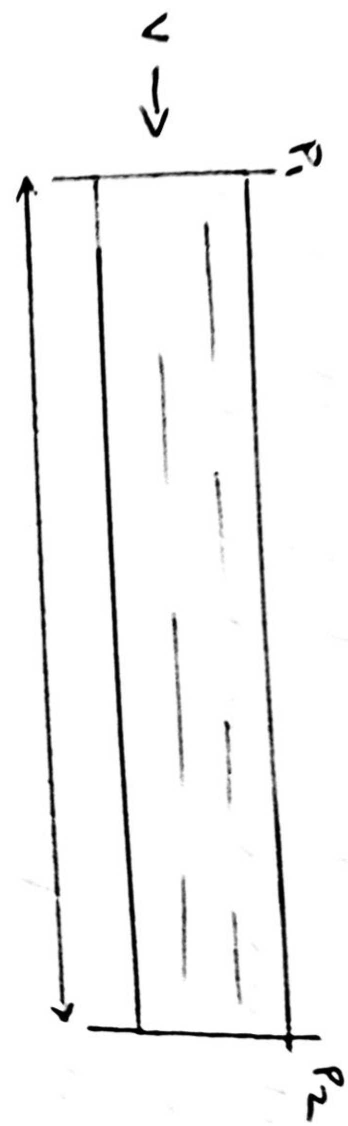
OUT PR, BASIC, 1

OUT PR, N LOAD, 1

FINISH/SOLUTION

SOLVE

RESULT



Length = 0.1524 m

$v = 3.3528$ m/s

$\rho = 1000$

$Q = \rho A V$

$= 1000 \times 29.17 \times 3.3528$

$= 97801.175$