## COURSE CONTENT

| ADVANCED COMPUTER AIDED DESIGN LABORATORY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **I Semester: CAD / CAM** | | | | | | | | |
| **Course Code** | **Category** | **Hours / Week** | | | **Credits** | **Maximum Marks** | | |
| **BCCD11** | **Core** | L | T | P | C | CIA | SEE | Total |
| | | 0 | 0 | 4 | 2 | 40 | 60 | 100 |
| **Contact Classes: Nil** | **Tutorial Classes: Nil** | **Practical Classes: 36** | | | | **Total Classes: 36** | | |

## I. COURSE OVERVIEW:

Computer aided Design laboratory is a course primary important to mechanical engineering students. The aim is to impart the overview of computer applications or design and manufacturing the discrete engine components, assemblies and final product to meet the global competition. The course covers the basics of geometric modeling, surface modeling and solid modeling. This course also deals with creation of synthetic curves and surfaces. It imposes the knowledge of latest manufacturing techniques using different programming methods, Group Technologies. It makes the student to understand the modern inspection methods and concepts of CAD.

## II. COURSE OBJECTIVES:

**The students will try to learn:**

I. The modern trends in design and manufacturing using CAD.
II. The significance of parametric technology and its application in 2D sketching.
III. The significance of parametric feature-based modeling and its application in 3D machine components modeling.
IV. The concepts of thermal analysis for transient heat transfer condition with different loads.

## III. COURSE OUTCOMES:

**After successful completion of the course, students should be able to:**

| | |
|---|---|
| CO1 | Select the Parametric Modeling Fundamentals, Procedure, and "Shape before Size" Approaches for Product design. |
| CO2 | Utilize graphics software for various CAD applications. |
| CO3 | Choose importance of CAD in the light of allied technologies such as CAM, CAE and FEA. |
| CO4 | Classify 3D assemblies that represent static and dynamic Mechanical Systems for assembly drawing. |
| CO5 | Utilization of different inputs using Part model and Assembly of parts. |
| CO6 | Develop the Generation of surfaces and Analysis of Models. |

## IV. COURSE CONTENT:

## EXERCISES ON ADVANCED COMPUTER AIDED DESIGN

**Note:** Students are encouraged to bring their own laptops for laboratorypractice sessions. All dimensions are in mm in experiments.

### Safety

Safety is a vital issue in all labs. Before using any equipment and machines or attempt practical work in a workshop everyone must understand basic safety rules. These rules will help keep all safe in the lab.

### Safety Rules

1. Always listen carefully to the teacher and follow instructions.
2. When learning how to use a computer / machine, listen very carefully to all the instructions given by the faculty / instructor. Ask questions, especially if you do not fully understand.
3. Bags should not be brought into a lab as people can trip over them.
4. Always be patient, never rush in the lab.
5. Keep your work area clean.

### 1. Getting Started Exercises

### 1.1 Introduction to AutoCAD

In the first lab period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor. Students should also make sure that they have all of the co-requisites and pre-requisites for the course at this time.

i) Familiarization of AutoCAD software and its advantages.
ii) Standard use of Computer Aided Design (CAD) drawings .dwg format
iii) Use of drawing, modifying and edit Commands.

### 1.2 Conventional Representation

Practice the conventional representation of materials and machine element which are used in assembly drawings.

1. Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs and ribs;
2. Certain droughting conventions are used to represent materials in section and machine elementsin engineering drawings.
3. As a variety of materials are used for machine components in engineering applications, it is preferable to have different conventions of section lining to differentiate between various materials.

**Hints:**

**Commands**

1. Type U (enter) change units in meters.
2. Type L (enter) to give line command and type dimensions as 0.8m. Indicate thedirection of the line is Ortho is ON.
3. Type O(enter) for offset command and type offset distance as 0.15 (enter) then,click inside where parallel line is required
4. Type “Tr” (enter) for trim command trim the extra lines.

5. By typing “DT” (enter) text command is given to write the text.
6. The size of dimensions and the size of arrows can be changed by typing(enter) command.
7. By typing “C“ (enter) to give circle command
8. By adopting the above command, the Representation of various materials isdrawn with dimensions.

## 2. PARTS AND ASSEMBLY MODELING

In order to show such features clearly, one or more views are drawn as if a portion had been cut away to reveal the interior This procedure is called sectioning and the view showing the cut away picture is called section view. A section is an imaginary cut taken through an object to reveal the shape or interior construction.

Types of sections, selection of section planes and drawing of sections and auxiliary sectional views, parts not usually sectioned. Orthographic views when carefully selected may reveal the external features of even the most complicated objects. However, there are objects with complicated interior details and when represented by hidden lines, may not effectively reveal the true interior details. This may be overcome by representing one or more of the views ‘in section’.

### 2.1 Exercise

1. Creating an assembly, moving components, assembling existing components, creating bill of materials, creating wire frame and surface geometry using generative shape design and sweep tools.

**Hint:**

Use drawing and modifying commands

**Try:**

Instead of 2D drawings develop the 3D components using AutoCAD software. Develop the 3D Drawings using catia and solid works software.

**COMMANDS USED:**

2D- SKETCHING

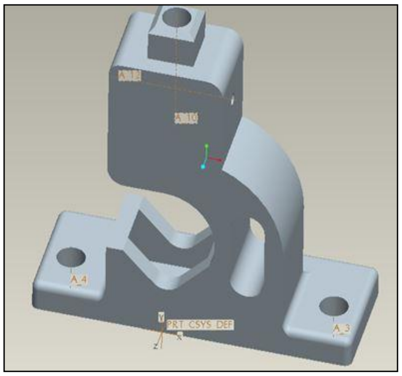
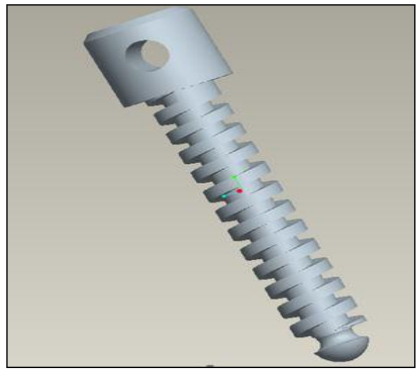
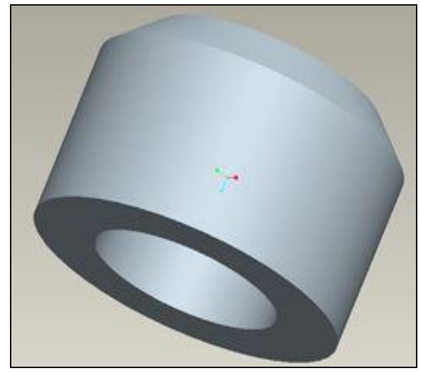
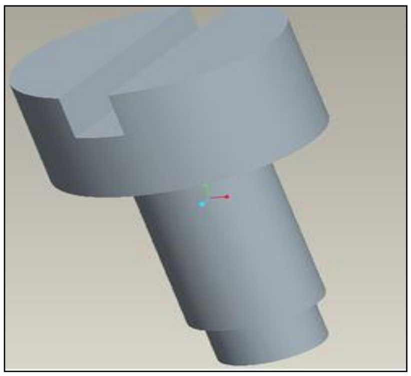
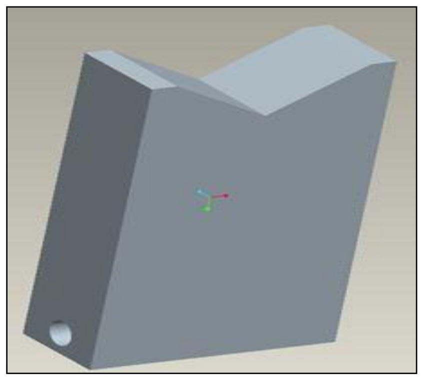
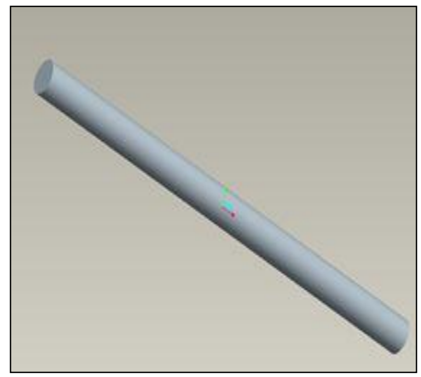
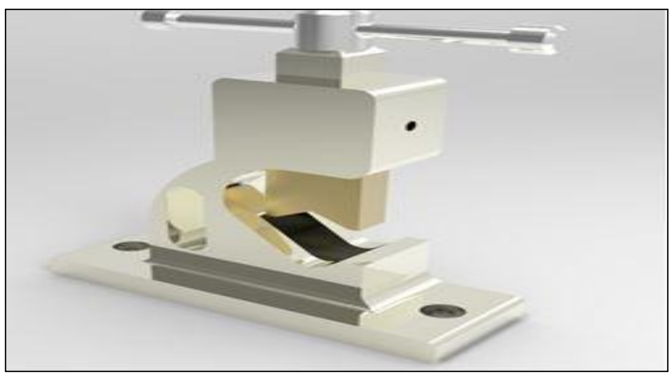
1. Line.
2. Circle.
3. Trim.

PART MODELING:

1. Revolve.
2. Extrude.
3. Cosmetic thread.

ASSEMBLY:

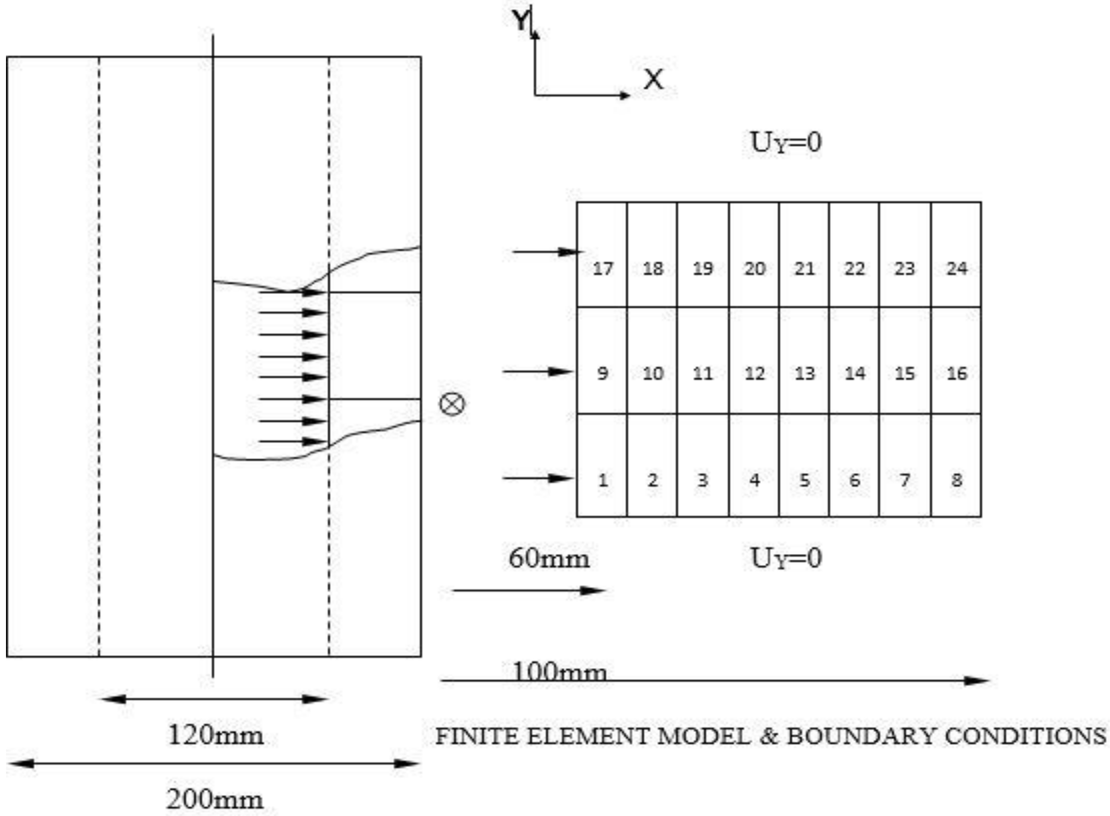
1. Add component
2. Align
3. Mate

## 3. STATIC ANALYSIS OF THICK CYLINDER

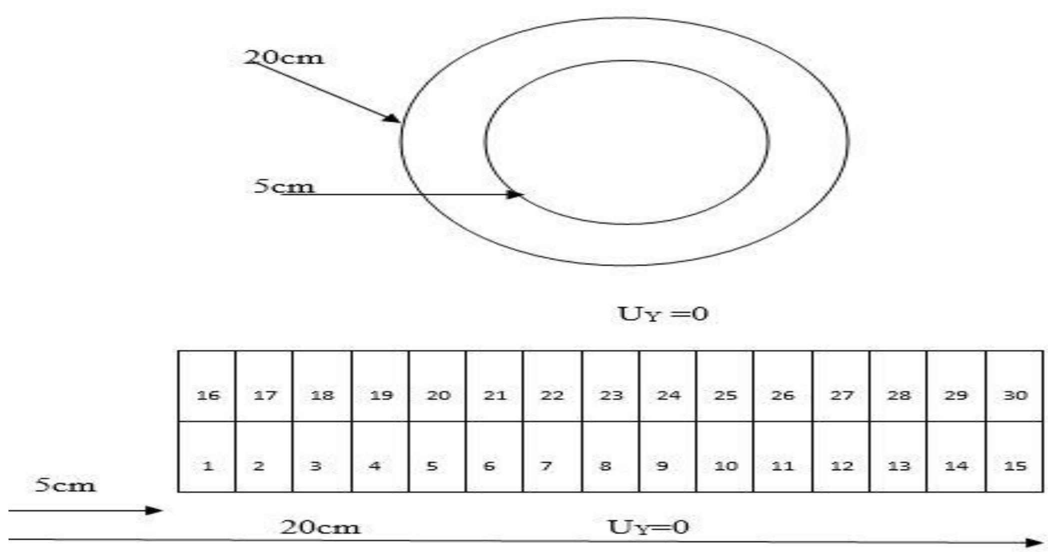
To compute the radial and circumferential stresses across the wall of the thick cylinder subjected to internal fluid pressure. A long and thick cylinder with an inner radius of 60 mm and outer radius of 100 mm is subjected to an internal pressure 64 MPa. The radial and circumferential stress distribution in the cylinder subjected an internal pressure computed by analysis package and compared with theoretical results.

**ELEMENT TYPE:** 2D – 8-Node axisymmetric structural solid element



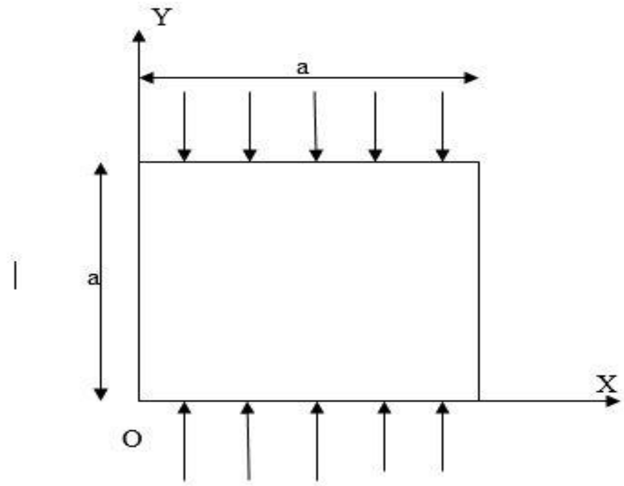

## 4. STRESS ANALYSIS OF ROTATING DISC

To compute the radial and circumferential stresses of the thin disc subjected to angular velocity. A circular thin disc of outer radius 20cm and inner radius 5cm is rotating at 3000rpm. Determine the radial and circumferential stress distribution in cylinder computed by analysis package and compared with theoretical results.



## 5. BUCKLING ANALYSIS OF PLATES

To compute the buckling load of the square plate subjected to pressure. A simply supported thin square plate of 1mx1m. Determine the critical buckling load in the plate computed by analysis package and compared with theoretical results.




**PROPERTIES:** Material: Steel

Modulus of elasticity: Ex = 200GPa = 2e11 N/$m^2$

Poisson ratio = 0.3

**BOUNDARY CONDITIONS:**

At origin (key point) - All DOF, At all lines $U_Z$=0

At the top line PRESSURE = 1 N/$m^2$

At the bottom line $U_Y$=0,

## 6. BUCKLING ANALYSIS OF PLATES

To perform large deflection analysis of a clamped edge circular plate subjected to uniform transverse pressure. A clamped circular plate of radius 360mm, thickness 10mm is subjected to a uniform transverse pressure on the top surface. The plate material is assumed to be linearly elastic.

**MATERIAL PROPERTIES**

The following material properties are considered for the present analysis.

I) Young's Modulus, E = 207GPa

II) Poisson's Ratio, ν = 0.3

**FINITE ELEMENT MODELING:**

Due to symmetry in geometry, loading, boundary conditions, half the diametric cross-sectional area of the plate is modeled as shown in Fig.1. The finite element mesh is generated with PLANE 82 of ANSYS software with axisymmetric option. PLANE 82 is a second order element which provides more accurate results for mixed (quadrilateral-triangular) automatic meshes and can tolerate irregular shapes without as much loss of accuracy. The 8-node elements have compatible displacement shapes and are well suited to model curved boundaries. The 8-node element is defined by eight nodes having two degrees of freedom at each node: translations in the nodal x and y directions. The element may be used as a plane element or as an axisymmetric element. The element has plasticity, creep, swelling, stress stiffening, large deflection, and large strain capabilities.

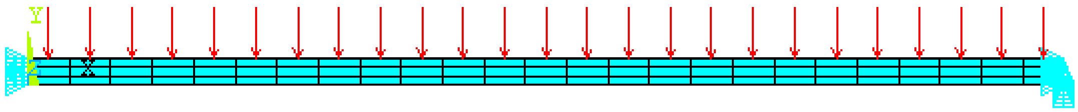


Fig. 1 FE model of plate

## 6. ANALYSIS OF A COMPOSITE PLATE

To compute the in-plane and interlaminar stresses in a four-layered composite plate subjected to uniaxial load using ANSYS software. A four-layered composite plate of 100mm*10mm*10mm is analyzed for in-plane and interlaminar stresses. All the four layers are of equal thickness. Two different stacking sequences I) cross-ply and ii) angle-ply are considered.

**Material Properties:**

i) Young's Modulus, $E_1$=175GPa, $E_2$=7GPa, $E_3$=7GPa,
ii) Poisson's Ratio, $\nu_{12}= \nu_{23=} \nu_{13}$ = 0.25
iii) Rigidity Modulus, $G_{12}$=$G_{13}$=3.5GPa, $G_{23}$=1.4GPa.

**Finite Element Model:**

**i) Mesh:**
The finite element mesh is generated on four volumes corresponding to four layers with an element edge length of 2.5mm.

**ii) Lay-up:**
Case-1: 0º/90º/90º/0º (Cross-ply)
Case-2: +45º/-45º/-45º/+45º (Angle-ply)

**iii) Boundary Conditions and loading:**
Symmetric boundary condition of $U_x$=0 is given at the central transverse plane of the plate i.e. at x=0 of F.E model.
Uniform pressure of 1MPa is applied on the opposite face (x=50)

Maximum values of in-plane and interlaminar stresses are determined in both the laminates and the results are presented in following Table.

| Laminate | In-plane Stresses | | | Layer | Interlaminar stresses | | |
|---|---|---|---|---|---|---|---|
| | $\sigma_x$ | $\sigma_y$ | $\tau_{xy}$ | | $\sigma_z$ | $\tau_{yz}$ | $\tau_{zx}$ |
| Cross-ply | | | | Outer | | | |
| | | | | Inner | | | |
| Angle-ply | | | | Outer | | | |
| | | | | Inner | | | |

## V. TEXT BOOKS:


1. Farid Amirouche, "Principles of Computer-Aided Design and Manufacturing, Pearson", 2nd edition, 2004.
2. P. Radha Krishnan, "CAD/ CAM/ CIM", New Age International, 4th edition, 2016.
3. Warren. S. Seames, "Computer Numerical Control Concepts and Programming", Delmar Cengage Learning, 4th edition, 2013.


## VI. E-TEXT BOOKS:


1. http://sbmpme.blogspot.in/2011/01/cad-cam-cim-p-radhakrishnan.html
2. https://www.scribd.com/doc/228624725/cad-cam-text-book-by-P-N-RAO