MACHINE DRAWING THROUGH CAD LABORATORY

III Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AMEC08	**Core**	0	0	2	1	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 36**				**Total Classes: 36**		
Prerequisite: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

Machine drawing is intended to communicate the necessary technical information required for manufacture and assembly of machine components. Students practice the development of drawings of machine components as per Bureau of Indian Standards (BIS) and assembly using industry leading mechanical design software's. It is used to develop a full range of products, from single parts to assemblies containing thousands of components with accurate fit and therefore involves economic, societal, safety and manufacturing aspects.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Code of drawing practice as per BIS conventions for mechanical elements using AutoCAD.
II. The 2D drawing of joints, couplings, bearings and keys and their sectional views.
III. The preparation of component drawings, assembly drawings and bill of materials for selected assemblies.
IV. The part drawings of the assembly of various machines and engine components.

III. COURSE OUTCOMES

CO 1	Interpret the various types of materials, machine elements and parts representation for machine drawings.
CO 2	Classify the different types of sectional views to reveal the internal surfaces of machine elements.
CO 3	Make use of the various machine elements to prepare the part drawings for the design process.
CO 4	Dem Draw the bearings, keys and cotter joints drawings for Assembly of machine parts.
CO 5	Categorize the couplings and riveted joints to fasten the components that require frequent assemblies.
CO 6	Develop an assembly drawings of Engine parts, Tailstock, Machine vice and safety valves to facilitate its manufacture

EXERCISES ON MACHINE DRAWING THROUGH CAD

Note: Students are encouraged to bring their own laptops for laboratory practice 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 draughting conventions are used to represent materials in section and machine elements in 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 the direction of the line is Ortho is ON.
3. Type 0(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 is drawn with dimensions.

2. SECTIONAL VIEWS

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 Exercises

1. Draw (i) the sectional view from the front, (ii) the view from above and (iii) the view from the right of the given shaft support.
2. Draw (i) the sectional view from the front, (ii) the view from above and (iii) the sectional view from the left of the given Machine block.

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.

3. Dimensioning

BASIC DIMENSIONING

In many applications, a drawing should contain annotations showing lengths or distances or angles between objects to convey the desired information. Dimensioning is the process of adding these annotations to a drawing. AutoCAD provides four basic types of dimensioning; linear, angular, diameter and radius.

DIM and DIMI Commands—DIMI command allows executing one dimensioning command and then returns to the normal command mode. If several dimensioning commands are to be executed, DIM command should be used. In this mode, the normal set of AutoCAD commands is replaced by a special set of dimensioning commands. To end the process of dimensioning, EXIT command has to be used. The elements of dimensioning include the projection line, dimension line, leader line, dimension line termination, the origin indication and the dimension itself.

Methods of dimensioning, general rules for sizes, and placement of dimensions for holes, centers, and curved and tapered features a drawing of a component, in addition to providing complete shape description, must also furnish information regarding the size description. These are provided through the distances between the surfaces, location of holes, nature of surface finish, type of material, etc. The expression of these features on a drawing, using lines, symbols, figures and notes is called dimensioning.

3.1 Exercises

Practice the Principles of Dimensioning and Standard abbreviations using Aligned System

i) Oblique dimensioning
ii) Angular dimensioning
iii) Chain Dimensions
iv) Parallel Dimensions
v) Dimensioning of chords, arcs and angles

Dimensions should be placed parallel to their dimension lines and preferably near the middle, above and clear-off the dimension line Fig. 1Dimensions may be written so that they can be read from the bottom or from the right side of the drawing. Dimensions on oblique dimension lines should be oriented as shown in Fig. 2 Angular dimensions may be oriented as shown in Fig. 3

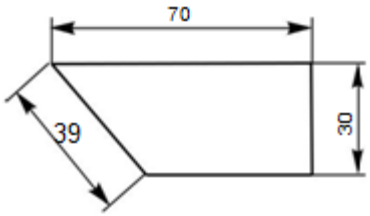


Fig. 1

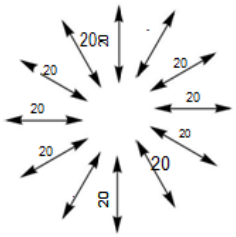


Fig. 2

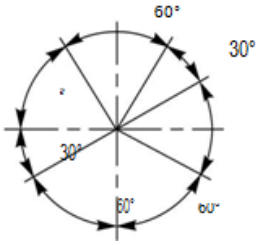


Fig. 3

Hints

1. Type U (enter) change units in meters.
2. Type L (enter) to give line command and type dimensions as 0.8m. Indicate the direction 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.
   By typing „DT" (enter) text command is given to write the text. By typing „DLI" (enter) dimensioning is also given.
5. The size of dimensions and the size of arrows can be changed by typing D (enter) command.
6. Use array command for angular dimensioning.
7. By adopting the above command the Representation of various dimensions are to be drawn

Try

Practice the Dimensioning using Uni-directional System method.

4. Machine elements

Drawing and sketching of machine elements in orthographic projections, spacing of views

Thread Profiles

V-Thread (sharp)

This thread profile has a larger contact area, providing more frictional resistance to motion. Hence, it is used where effective positioning is required. It is also used in brass pipe work. British Standard

Whitworth (B.S.W) Thread. This thread form is adopted in Britain in inch units. The profile has rounded ends, making it less liable to damage than sharp V-thread.

Buttress Thread

This thread is a combination of V-and square threads. It exhibits the advantages of square thread, like the ability to transmit power and low frictional resistance, with the strength of the V-thread. It is used where power transmission takes place in one direction only such as screw press, quick acting carpenter's vice, etc.

Square Thread

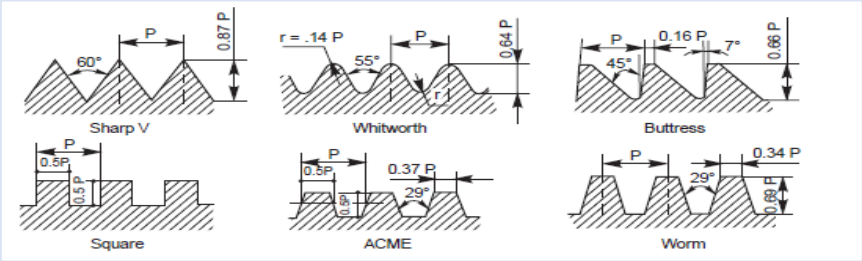
Square thread is an ideal thread form for power transmission. In this, as the thread flank is at right angle to the axis, the normal force between the threads, acts parallel to the axis, with zero radial components. This enables the nut to transmit very high pressures, as in the case of a screw jack and other similar applications.

ACME Thread

It is a modified form of square thread. It is much stronger than square thread because of the wider base and it is easy to cut. The inclined sides of the thread facilitate quick and easy engagement and disengagement as for example, the split nut with the lead screw of a lathe.

Worm Thread

Worm thread is similar to the ACME thread, but is deeper. It is used on shafts to carry power to worm wheels.



4.1 Exercises

1. Draw Screw thread nomenclature, forms of threads, Thread series, Thread designation, Representation of threads, Bolted joints, locking arrangement for nuts, Foundation bolts
2. Draw Screwed (Threaded) fasteners: Hexagonal (Bolt Head) Nut
3. Draw the three views of a hexagonal headed bolt of nominal diameter 25 mm and length 100 mm; with a hexagonal nut and washer.

Hints

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Empirical relations:
Major or nominal diameter of
bolt                          = D
Thickness of nut, T           = D
Width of nut across flat surfaces, W = 1.5D + 3 mm
Radius of chamfer, R     = 1.5D
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Try;

1. Instead of 2D drawings develop the Hexagonal (Bolt Head) Nut in 3D using Solid works software
2. Instead of 2D drawings develop the 3D components using AutoCAD software.
3. Develop the 3D Drawings using catia and solid works software.

5. Keys and Cotter Joints

A cotter is a flat wedge shaped piece, made of steel. It is uniform in thickness but tapering in width, generally on one side; the usual taper being 1:30. The lateral (bearing) edges of the cotter and the bearing slots are generally made semi-circular instead of straight (Fig. 1.0).

This increases the bearing area and permits drilling while making the slots. The cotter is locked in position by means of a screw as shown in Fig. 1.1. Cotter joints are used to connect two rods, subjected to tensile or compressive forces along their axes. These joints are not suitable where the members are under rotation. The following are some of the commonly used cotter joints:

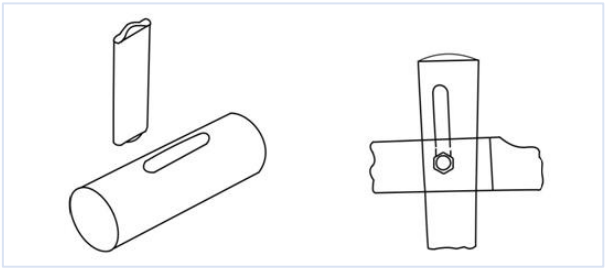

Fig. 1.0 Cotter and the bearing slot Fig. 1.1 Locking arrangement of cotter

Knuckle Joint

A knuckle joint is a pin joint used to fasten two circular rods. In this joint, one end of the rod is formed into an eye and the other into a fork (double eye). For making the joint, the eye end of the rod is aligned into the fork end of the other and then the pin is inserted through the holes and held in position by means of a collar and a taper pin (Fig. 1.0). Once the joint is made, the rods are free to swivel about the cylindrical pin.

Knuckle joints are used in suspension links, air brake arrangement of locomotives, etc.

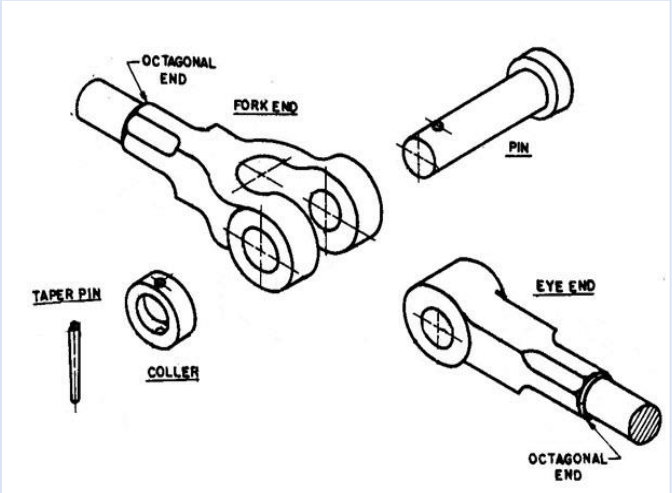

Fig. 1.0

1.1 Exercises

1. Draw the sectional view from the front, and view from the side of a cotter joint with sleeve used to connect two rods of 50 mm diameter each.
2. Draw a Knuckle joint with 50 mm diameter (D)
3. Sketch the following types of keys in two views, as fitted in position between a shaft and the mounting. Choose the shaft diameter as 30 mm and the hub diameter of the mounting as 60 mm:
   a. Hollow saddle key, (b) flat saddle key,
   b. Taper sunk key, (d) single headed feather key,
   c. Splines and (f) woodruff key.

Try

Draw the sectional views of Cotter Joint with Socket and Spigot Ends in 3D using Solid works software.

6. Riveted joints

To study & draw Riveted Joints, Rivets and riveting, Rivet heads, Classification of riveted joints

Riveted joints are permanent fastenings and riveting is one of the commonly used method of producing rigid and permanent joints. Manufacture of boilers, storage tanks, etc., involve joining of steel sheets, by means of riveted joints. These joints are also used to fasten rolled steel sections in structural works, such as bridge and roof trusses.

6.1 Practice the various types of riveted joints.

Draw (a) sectional view from the front and (b) view from above, of the following riveted joints, to join plates of thickness 10 mm:

(i) Single riveted lap joint,
(ii) Double riveted chain lap joint,
(iii) Single riveted, single strap butt joint

Try;

Draw the sectional views of Double riveted, Double strap butt joint

7. COUPLINGS

Couplings are used to join two shafts so that they act as a single unit during rotation and power can be transmitted from one shaft to the other.

7.1 Exercise

Assemble the parts of a protected flanged coupling and draw the following views:

(i) Half sectional view from the front, with top half in section, and
(ii) View from the right.

8. BEARINGS

Bearings are supports for shafts, providing stability, and free and smooth rotation. The importance of bearings may be understood from the supporting requirement of machine tool spindles, engine crankshafts, transmission or line shafts in workshops, etc. Bearings are broadly classified into two categories: sliding contact bearings and rolling contact bearings or anti-friction bearings.

8.1 Exercises

Draw (a) sectional view from the front and (b) view from above, of the following bearings

i) Journal Bearing

ii) Pivot Bearing
iii) Collar bearing.

9. ASSEMBLY DRAWINGS-I

Assembly drawings for the Engine parts–stuffing box, Eccentrics, I.C. engine connecting rod. A machine is an assembly of various links or parts. It is necessary to understand the relation between the various parts of the unit for the purpose of design and production. An assembly drawing is one which represents various parts of a machine in their working position. These drawings are classified as design assembly drawings, working assembly drawings, sub-assembly drawings, installation assembly drawings, etc. The final assembly drawings are prepared from design assembly drawings or from the working drawings (component drawings).

9.1 Exercises

Assemble all parts of the stuffing box for a vertical steam engine, and draw,
(i) Half sectional view from the front, with left half in section, (ii) half sectional view from the right and
(iii) view from above.

Try

1. Instead of 2D drawings develop the assembly drawing in 3D using Solid works software
2. Develop the 3D components using AutoCAD software.
3. Develop the 3D Drawings using catia and solid works software.

10. ASSEMBLY DRAWINGS-II

Screw jacks are used for raising heavy loads through very small heights. In this, the screw works in the nut which is press fitted into the main body. The tommy bar is inserted into a hole through the enlarged head of the screw and when this is turned, the screw will move up or down, thereby raising or lowering the load.

10.1 Exercises

Assemble all parts of the screw jack, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software

11. ASSEMBLY DRAWINGS-III

Assembly drawings for the Machine vice
It consists of the base which is clamped to the machine table using two T-bolts. The sliding block is fixed in the centre slot of the base by means of the guide screw. The movable jaw is fixed to the sliding block with four screws. One of the serrated plates is fixed to the jaw of the base by means of screws and the other to the movable jaw by the one end of the guide screw is fixed to the base by means of the washer and nut. The movable jaw is operated by means of a handle which fits onto the square end of the guide screw.

11.1 Exercises

Assemble all parts of the Machine vice, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

12. ASSEMBLY DRAWINGS-IV

Certain jobs requiring milling operations, in relation to their axes of rotation, are usually supported between centers. The job is held between the centre in the dividing head and adjustable center provided in the tail-stock. This is similar to the lathe tail-stock.

12.1 Exercises

Assemble all parts of the tailstock, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software

13. ASSEMBLY DRAWINGS-V

Assembly drawings for the Rams-bottom Safety Valve
In Rams-bottom safety valve, spring load is used to lift the valves, when excess pressure of steam is built-up. It is mostly used in a locomotive boiler. Whenever steam pressure exceeds the designed value of the spring force, the excess pressure lifts the valves, allowing steam to escape till the pressure decreases to the permissible value.

13.1 Exercises

Assemble all parts of the Rams-bottom Safety Valve, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software.

14. ASSEMBLY DRAWINGS-VI

Assembly drawings for the connecting rod
Assemble all parts of connecting rod, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software

V. REFERENCE BOOKS

1. K.L. Narayana, P. Kannaiah, K. Venkata Reddy, "Machine Drawing", New Age Publishers, 3rd edition, 2012.
2. K.C. John, "Text book of Machine Drawing", PHI Eastern Economy, 1st edition, 2010.
3. P.S Gill, "Machine Drawing", S.K Kataria & Sons, 1st edition, 2013
4. N. D. Bhatt, V. M Pancahal, "Machine Drawing", Charotar, 1st edition, 2014.

VI. REFERENCE BOOKS

1. http://www.iare.ac.in