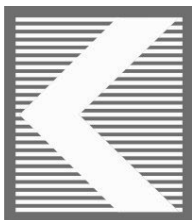


# ENGINEERING GRAPHICS & DESIGN

**PRADEEP JAIN**



**KHANNA BOOK PUBLISHING CO. (P) LTD.**

PUBLISHER OF ENGINEERING AND COMPUTER BOOKS

4C/4344, Ansari Road, Darya Ganj, New Delhi-110002

**Phone:** 011-23244447-48

**Mobile:** +91-99109 09320

**E-mail:** [contact@khannabooks.com](mailto:contact@khannabooks.com)

**Website:** [www.khannabooks.com](http://www.khannabooks.com)

Dear Readers,

To prevent the piracy, this book is secured with HIGH SECURITY HOLOGRAM on the front title cover. In case you don't find the hologram on the front cover title, please write us to at [contact@khannabooks.com](mailto:contact@khannabooks.com) or whatsapp us at +91-99109 09320 and avail special gift voucher for yourself.

Specimen of Hologram on front Cover title:



Moreover, there is a SPECIAL DISCOUNT COUPON for you with EVERY HOLOGRAM.

How to avail this SPECIAL DISCOUNT:

Step 1: Scratch the hologram

Step 2: Under the scratch area, your “coupon code” is available

Step 3: Logon to [www.khannabooks.com](http://www.khannabooks.com)

Step 4: Use your “coupon code” in the shopping cart and get your copy at a special discount

Step 5: Enjoy your reading!

**ISBN:** 978-93-91505-06-6

**Book Code:** UG004EN

## **Engineering Graphics & Design**

*by* Pradeep Jain

**[English Edition]**

**First Edition:** 2021

*Published by:*

**Khanna Book Publishing Co. (P) Ltd.**

Visit us at: [www.khannabooks.com](http://www.khannabooks.com)

Write us at: [contact@khannabooks.com](mailto:contact@khannabooks.com)

CIN: U22110DL1998PTC095547

To view complete list of books,  
Please scan the QR Code:



*Printed in India.*

### **Copyright © Reserved**

No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior permission of the publisher.

This book is sold subject to the condition that it shall not, by way of trade, be lent, re-sold, hired out or otherwise disposed of without the publisher's consent, in any form of binding or cover other than that in which it is published.

**Disclaimer:** The website links provided by the author in this book are placed for informational, educational & reference purpose only. The Publisher do not endorse these website links or the views of the speaker/ content of the said weblinks. In case of any dispute, all legal matters to be settled under Delhi Jurisdiction only.



प्रो. अनिल डी. सहस्रबुद्धे

अध्यक्ष

**Prof. Anil D. Sahasrabudhe**

Chairman



सत्यमेव जयते

**अखिल भारतीय तकनीकी शिक्षा परिषद्**

(भारत सरकार का एक सांविधिक निकाय)

(शिक्षा मंत्रालय, भारत सरकार)

नेल्सन मंडेला मार्ग, वसंत कुंज, नई दिल्ली-110070

दूरभाष : 011-26131498

ई-मेल : [chairman@aicte-india.org](mailto:chairman@aicte-india.org)

**ALL INDIA COUNCIL FOR TECHNICAL EDUCATION**

(A STATUTORY BODY OF THE GOVT. OF INDIA)

(Ministry of Education, Govt. of India)

Nelson Mandela Marg, Vasant Kunj, New Delhi-110070

Phone : 011-26131498

E-mail : [chairman@aicte-india.org](mailto:chairman@aicte-india.org)

## FOREWORD

Engineering has played a very significant role in the progress and expansion of mankind and society for centuries. Engineering ideas that originated in the Indian subcontinent have had a thoughtful impact on the world.

All India Council for Technical Education (AICTE) had always been at the forefront of assisting Technical students in every possible manner since its inception in 1987. The goal of AICTE has been to promote quality Technical Education and thereby take the industry to a greater heights and ultimately turn our dear motherland India into a Modern Developed Nation. It will not be inept to mention here that Engineers are the backbone of the modern society - better the engineers, better the industry, and better the industry, better the country.

NEP 2020 envisages education in regional languages to all, thereby ensuring that each and every student becomes capable and competent enough and is in a position to contribute towards the national growth and development.

One of the spheres where AICTE had been relentlessly working from last few years was to provide high-quality moderately priced books of International standard prepared in various regional languages to all it's Engineering students. These books are not only prepared keeping in mind it's easy language, real life examples, rich contents and but also the industry needs in this everyday changing world. These books are as per AICTE Model Curriculum of Engineering & Technology – 2018.

Eminent Professors from all over India with great knowledge and experience have written these books for the benefit of academic fraternity. AICTE is confident that these books with their rich contents will help technical students master the subjects with greater ease and quality.

AICTE appreciates the hard work of the original authors, coordinators and the translators for their endeavour in making these Engineering subjects more lucid.

(Anil D. Sahasrabudhe)



## **Acknowledgement**

---

**T**he author grateful to AICTE for their meticulous planning and execution to publish the technical book for Engineering and Technology students.

I sincerely acknowledge the valuable contributions of the reviewer of the book Prof. B.S. Pabla, for making it students' friendly and giving a better shape in an artistic manner.

This book is an outcome of various suggestions of AICTE members, experts and authors who shared their opinion and thoughts to further develop the engineering education in our country.

It is also with great honour that I state that this book is aligned to the AICTE Model Curriculum and in line with the guidelines of National Education Policy (NEP) -2020. Towards promoting education in regional languages, this book is being translated in scheduled Indian regional languages.

Acknowledgements are due to the contributors and different workers in this field whose published books, review articles, papers, photographs, footnotes, references and other valuable information enriched us at the time of writing the book.

Finally, I like to express my sincere thanks to the publishing house, M/s. Khanna Book Publishing Company Private Limited, New Delhi, whose entire team was always ready to cooperate on all the aspects of publishing to make it a wonderful experience.

**Pradeep Jain**



## **Preface**

---

The traditional engineering graphics course has undergone significant change due to emergence of computer-aided drafting and design (CAD) tools and the revision of engineering graphics curriculum to include computer based 2D and 3D modeling. The emphasis has shifted from drawing board based engineering graphics to CAD based modeling which has the advantages of speed, flexibility and convenience of drawing. In spite of these the focus on free hand sketching and development of ability to visualize the objects in 2D and 3D frame has been retained in the revised curriculum. The text book on “Engineering Graphics & Design” addresses the challenges of integrating computer aided drawing and design to develop the drafting manual skills and to integrate the computer based drafting without losing focus on the basic drawing skills. The book has been aligned to outcome based education to focus on the learning outcomes leading to attainment of program outcomes. Course outcomes and unit outcomes have been defined for each unit of the curriculum. COs have been mapped with the POs to enable the students to appreciate and work for attainment of program outcomes. The text matter has been reduced to make it easier to students. Each chapter is followed by a set of questions and the references for further reading. The first part of the book covers the conventional aspects of engineering drawing and the second part is devoted to the use of computer aided drafting.

It is sincerely hoped that the book will redefine the learning of engineering graphics and design with focus on development of visualization of engineering objects and use of computer software in developing 2D and 3D models.

Author will thankfully acknowledge the comments and suggestions for the future improvements of the book.

**Pradeep Jain**





# Outcome Based Education

---

For the implementation of an outcome based education the first requirement is to develop an outcome based curriculum and incorporate an outcome based assessment in the education system. By going through outcome based assessments evaluators will be able to evaluate whether the students have achieved the outlined standard, specific and measurable outcomes. With the proper incorporation of outcome based education there will be a definite commitment to achieve a minimum standard for all learners without giving up at any level. At the end of the programme running with the aid of outcome based education, a student will be able to arrive at the following outcomes:

- PO-1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO-2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO-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.
- PO-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.
- PO-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.
- PO-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.
- PO-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.
- PO-8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO-9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

- PO-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.
- PO-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.
- PO-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.

## Course Outcomes

---

After completion of the course the students will be able to:

**CO-1:** Demonstrate the visual understanding of engineering drawing.

**CO-2:** Create working engineering drawings.

**CO-3:** Apply computer aided drafting for 2 D and 3 D modeling.

**CO-4:** Apply the modern engineering tools necessary for engineering practice.

**CO-5:** Read and communicate through engineering drawings.

### Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Expected Mapping with Program Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	1	-	-	1	-	-	-	-	-	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-
CO-3	3	2	3	1	3	2	-	-	-	-	-	-
CO-4	3	2	1	1	3	2	-	-	-	-	-	-
CO-5	3	2	2	-	-	2	-	-	-	3	-	-

## **Abbreviations**

---

2D	Two Dimensional
3D	Three Dimensional
Aux	Auxiliary
BIS	Bureau of Indian Standards
CAD	Computer-aided design
CO	Course Outcome
CUI	Customize User Interface
FV	Front View
GUI	Graphical User Interface
HP	Horizontal plane
HT	Horizontal trace
IS	Indian standard
ISO	International Organization for Standardization
LOS	Line of Sight
OSNAP	Object SNAP
PO	Programme Outcomes
PP	Profile Plane
RF	Representative Fraction
THK	Thick
TL	True Length
TV	Top View
UCS	User Coordinate System
UO	Unit Outcomes
VP	Vertical Plane
VT	Vertical Trace

# List of Figures

---

## UNIT 1: INTRODUCTION TO ENGINEERING DRAWING

Figure 1.1: Standard Sizes of Drawing Sheets	3
Figure 1.2: Drawing Sheet Layout	3
Figure 1.3: Drawing Sheet Title Block	4
Figure 1.4: Drawing Board	4
Figure 1.5: Mini Drafter	5
Figure 1.6: T-Square	6
Figure 1.7: French Curves	7
Figure 1.8: Grade of pencil leads	7
Figure 1.9: Lettering Features used in Engineering Drawing	8
Figure 1.10: Vertical Lettering	9
Figure 1.11: Inclined or Italic Lettering	9
Figure 1.12: Roman lettering	9
Figure 1.13: Plain scale	10
Figure 1.14: Diagonal Scale	11
Figure 1.15: Vernier scale	11
Figure 1.16: Comparative Scale	12
Figure 1.17: Scale of chords	12
Figure 1.18: Construction of an Angle by Scale of Chords	13
Figure 1.19: Plain Scale R.F. 1/5	13
Figure 1.20: Diagonal scale R.F. 1/300	14
Figure 1.21: Vernier Scale with R.F. =1/25	15
Figure 1.22: Ellipse	15
Figure 1.23: Generation of Ellipse	16
Figure 1.24: Parabola	17
Figure 1.25: Generation of Parabola	18
Figure 1.26: Hyperbola	18
Figure 1.27: Generation of Hyperbola	19
Figure 1.28: Generation of Cycloid	20
Figure 1.29: Generation of Epicycloids	21
Figure 1.30 Construction of Hypocycloid	22
Figure 1.31: Generation of Involute	22

## UNIT 2: ORTHOGRAPHIC PROJECTION

Figure 2.1: Theory of Projection	32
Figure 2.2: Types of Projection	32
Figure 2.3: Isometric, Dimetric and Trimetric Projections	33
Figure 2.4: Oblique Projections	34
Figure 2.5: Theory of Perspective Projection	34

Figure 2.6: Orthographic Multi-view Projection	35
Figure 2.7: Principal Planes	36
Figure 2.8: Orthographic Projection Views	36
Figure 2.9: Symbol of First Angle Projection	37
Figure 2.10: Symbol of Third Angle Projection	37
Figure 2.11: Projection of a Point in First Quadrant	39
Figure 2.12: Projection of a Point in Third Quadrant	39
Figure 2.13: Projection of Point A	40
Figure 2.14: Projection of Point P	40
Figure 2.15: Projection of point B	41
Figure 2.16: Projection of Point B	41
Figure 2.17 : Projection of Line Parallel to both the Planes	42
Figure 2.18: Projection of line Perpendicular to HP and Parallel to VP	43
Figure 2.19 : Projection of line perpendicular to VP and parallel to HP	43
Figure 2.20: Projection of Line Inclined to HP and Parallel to VP	44
Figure 2.21: Projection of Line Inclined to VP and Parallel to HP	44
Figure 2.22: Projection of Line Contained by HP and Parallel to VP	45
Figure 2.23: Projection of Line Contained by VP and Parallel to HP	45
Figure 2.24: Projection of Line Contained by VP and HP	45
Figure 2.25(a): Projection of a Line inclined to both HP and VP	46
Figure 2.25 (b): Projection of a Line inclined to both HP and VP	46
Figure 2.25 (c): Projection of a Line Inclined to both HP and VP	47
Figure 2.25 (d): Projection of a Line Inclined to both HP and VP	47
Figure 2.26: Projection of a Line Contained by one or both Planes	48
Figure 2.27: Projection of Line AB	48
Figure 2.28: Projection of Line AB Inclined to both the Planes	49
Figure 2.29: Projection of Line for Given FV and TV	50
Figure 2.30: Different Shapes of Plane	50
Figure 2.31: Projection of Planes Perpendicular to H.P. and Parallel to V.P.	51
Figure 2.32: Projection of Planes Perpendicular to V.P. and Parallel to H.P.	52
Figure 2.33: Projection of Planes Perpendicular to H.P. and V.P.	53
Figure 2.34: Projection of Planes Perpendicular to H.P. and Inclined to V.P.	53
Figure 2.35: Projection of Planes Perpendicular to V.P. and Inclined to H.P.	53
Figure 2.36: Projection of Hexagonal Plate	54
Figure 2.37: Projection of a Circle of 5 cm Diameter	54
Figure 2.38: Projection of a Rhombus	55
Figure 2.39: Projection of Pentagonal of 25 mm Side	55
Figure 2.40: Projection of Rectangular Plate	56

### UNIT 3: PROJECTION OF SOLIDS

Figure 3.1: Tetrahedron	64
Figure 3.2: Cube or Hexahedron	64

Figure 3.3: Octahedron	65
Figure 3.4: Dodecahedron	65
Figure 3.5: Icosahedrons	65
Figure 3.6: Regular Prisms	66
Figure 3.7: Right pyramids	66
Figure 3.8: Cylinder	66
Figure 3.9: Sphere	67
Figure 3.10: Cone	67
Figure 3.11: Frustum	67
Figure 3.12: Truncated	68
Figure 3.13: Projection of a Cylinder with Axis Perpendicular to HP	69
Figure 3.14: Projection of a Cylinder with its Axis Perpendicular to VP	70
Figure 3.15: Projection of a Cone with Axis Parallel to both HP and VP	70
Figure 3.16: Projection of a Pentagonal Prism Axis parallel to HP and Inclined to VP	71
Figure 3.17: Projection of a Hexagonal Pyramid Axis Inclined to HP and Parallel to VP	72
Figure 3.18: Projection of a right circular cylinder	73
Figure 3.19: Projection of a Pentagonal Prism	74
Figure 3.20: Projection of a Cylinder	74
Figure 3.21: Projection of a Cube	75
Figure 3.22: Projection of a Pentagonal Pyramid	75
Figure 3.23: Projection of a Square Pyramid	76
Figure 3.24: Drawing of Floor Plan	77
<b>UNIT 4: SECTIONAL VIEWS OF SOLIDS</b>	
Figure 4.1: Full Section View	84
Figure 4.2: Half Section View	85
Figure 4.3: Offset Section	85
Figure 4.4: Revolved Section	86
Figure 4.5: Removed Section	86
Figure 4.6: Broken-out Section	87
Figure 4.7: Representation of Sectional Plane	87
Figure 4.8: Section Lining	88
Figure 4.9: Section Plane Perpendicular to V.P. and Parallel to H.P.	88
Figure 4.10: Section Plane Perpendicular to H.P. and Parallel to V.P.	88
Figure 4.11: Section Plane Perpendicular to H.P. and Inclined to V.P.	89
Figure 4.12: Sectional Plane is Perpendicular to V.P. and Inclined to H.P.	89
Figure 4.13: Sectional Views of Prism	90
Figure 4.14: Sectional Views and True Shape of Square Pyramid	91
Figure 4.15: Sectional Views and True Shape of Right Circular Cone	92
Figure 4.16: Sectional Views of a Cylinder	93
Figure 4.17: Development of Right Regular Prism	94

Figure 4.18: Development of Right Regular Cylinder	95
Figure 4.19: Development of Right Regular Pyramid	95
Figure 4.20: Development of Right Circular Cone	96
Figure 4.21: Development of Hexagonal Prism	97
Figure 4.22: Development of Cylinder	98
Figure 4.23: Development of Pentagonal Pyramid	99
Figure 4.24: Development of Truncated Cone	99
Figure 4.25: Transition pieces	106

## **UNIT 5: ISOMETRIC PROJECTION**

Figure 5.1: Principle of Isometric Projection	110
Figure 5.2: Front View of Cube	111
Figure 5.3: Construction of Isometric Scale	112
Figure 5.4: Isometric View of Square	113
Figure 5.5: Isometric View of Triangle	114
Figure 5.6: Isometric View of Circle	114
Figure 5.7: Isometric View of Circle Using Centre Method	115
Figure 5.8: Isometric View of Pentagon	115
Figure 5.9: Isometric View of a Irregular Shape	116
Figure 5.10: Isometric View of a Pentagonal Prism	117
Figure 5.11: Isometric View of a Cylinder	118
Figure 5.12: Isometric View of a Cone	119
Figure 5.13: Isometric View of a Sphere	119
Figure 5.14: Isometric View of a Pentagonal Pyramid	120
Figure 5.15: Isometric View of Compound Solid	121
Figure 5.16 (a): Orthographic Views	121
Figure 5.16 (b): Isometric Axes	122
Figure 5.16 (c): Drawing Line Parallel to Isometric Axes	122
Figure 5.16 (d): Locate the Principal Corners	122
Figure 5.16 (e): Isometric Drawing	122
Figure 5.17: Conversion of Isometric View to Orthographic Projections	123

## **UNIT 6: OVERVIEW OF COMPUTER GRAPHICS**

Figure 6.1: Computer Graphic System	133
Figure 6.2: CAD Workstation	133
Figure 6.3: AutoCAD Workspace Selection	135
Figure 6.4: GUI of AutoCAD	136
Figure 6.5: Layout of Application Menu	136
Figure 6.6: Layout of Pull-down Menus	137
Figure 6.7: Layout of Short Cut Menu	137
Figure 6.8: Layout of Standard Tool Bars	138
Figure 6.9: Coordinate System Icon	138



Figure 6.10: Cartesian coordinate system	139
Figure 6.11: Polar Coordinate System	139
Figure 6.12: Polar Coordinate System Angle Direction	139
Figure 6.13: Relative Coordinate System	140
Figure 6.14: Crosshairs, Pickbox, and Cursor Icon	140
Figure 6.15: Command Window	141
Figure 6.16: Navigation tool bar	141
Figure 6.17: Quick Access Toolbar	141
Figure 6.18: Status Bar	142
Figure 6.19: A typical Text Window	142
Figure 6.20: Point Selection	143
Figure 6.21: Object Selection Using Window	144
Figure 6.22: Object selection using crossing window	144
Figure 6.23: Selecting Objects with a Crossing Line	144
Figure 6.24: Graphics standards	148
 <b>UNIT 7: CUSTOMIZATION &amp; CAD</b>	
Figure 7.1: Startup Dialog Box	154
Figure 7.2: Drawing Units	155
Figure 7.3: Customize User Interface	156
Figure 7.4: Geometric constraint options	157
Figure 7.5: OSNAP Toolbar	160
Figure 7.6: Snap and Grid in Drafting Setting	161
Figure 7.7: Grid Setup	162
Figure 7.8: Grid Spacing	162
Figure 7.9: Snap On	163
Figure 7.10: Ortho Mode (ON / OFF)	163
 <b>UNIT 8: ANNOTATION LAYERS AND 3D MODELLING</b>	
Figure 8.1: Text Pallet Window	194
Figure 8.2: MTEXT Command	194
Figure 8.3: Single Line TEXT Command	195
Figure 8.4: Deviation Type Tolerance	196
Figure 8.5: Tolerance Format Panel	196
Figure 8.6: Layer Properties Manager	198
Figure 8.7: Section style manager	199
Figure 8.8: Plot Panel AutoCAD	200
Figure 8.9: Wireframe Model	203
Figure 8.10: Surface Modeling	203
Figure 8.11: Solid primitives	204
Figure 8.12: EXTRUDE in AutoCAD	204
Figure 8.13: REVOLVE Command in AutoCAD	205

Figure 8.14: Sweep Command in AutoCAD	206
Figure 8.15: UNION of Objects	206
Figure 8.16: Subtraction of Objects	207
Figure 8.17: Intersection of Objects	208

## List of Tables

---

Table 1.1: Standard sizes of drawing sheets	2
Table 1.2: Description of the size of standard drawing boards	5
Table 1.3: Standard sizes of ‘T’ square	6
Table 1.4: The letter sizes recommended for various items	8
Table 1.5: Types of lines	26
Table 2.1: Difference between parallel and perspective projection	35
Table 2.2: Difference between first angle and third angle projection	38
Table 5.1: Difference between isometric view and isometric projection	113
Table 7.1: Geometric Constrained and Description	157
Table 7.2: OSNAPS Modes	160

## Guidelines for Teachers

To implement Outcome Based Education (OBE) knowledge level and skill set of the students should be enhanced. Teachers should take a major responsibility for the proper implementation of OBE. Some of the responsibilities (not limited to) for the teachers in OBE system may be as follows:

- Within reasonable constraint, they should manipulate time to the best advantage of all students.
- They should assess the students only upon certain defined criterion without considering any other potential ineligibility to discriminate them.
- They should try to grow the learning abilities of the students to a certain level before they leave the institute.
- They should try to ensure that all the students are equipped with the quality knowledge as well as competence after they finish their education.
- They should always encourage the students to develop their ultimate performance capabilities.
- They should facilitate and encourage group work and team work to consolidate newer approach.
- They should follow Blooms taxonomy in every part of the assessment.

### Bloom's Taxonomy

Level	Teacher should Check	Student should be able to	Possible Mode of Assessment
Creating	Students ability to create	Design or Create	Mini project
Evaluating	Students ability to Justify	Argue or Defend	Assignment
Analysing	Students ability to distinguish	Differentiate or Distinguish	Project/Lab Methodology
Applying	Students ability to use information	Operate or Demonstrate	Technical Presentation/ Demonstration
Understanding	Students ability to explain the ideas	Explain or Classify	Presentation/Seminar
Remembering	Students ability to recall (or remember)	Define or Recall	Quiz

## Guidelines for Students

Students should take equal responsibility for implementing the OBE. Some of the responsibilities (not limited to) for the students in OBE system are as follows:

- Students should be well aware of each UO before the start of a unit in each and every course.
- Students should be well aware of each CO before the start of the course.
- Students should be well aware of each PO before the start of the programme.
- Students should think critically and reasonably with proper reflection and action.
- Learning of the students should be connected and integrated with practical and real life consequences.
- Students should be well aware of their competency at every level of OBE.

# Contents

---

<i>Foreword</i>	<i>iii</i>
<i>Acknowledgement</i>	<i>v</i>
<i>Preface</i>	<i>vii</i>
<i>Outcome Based Education</i>	<i>ix</i>
<i>Course Outcomes</i>	<i>xi</i>
<i>Abbreviations</i>	<i>xii</i>
<i>List of Figures</i>	<i>xiii</i>
<i>List of Tables</i>	<i>xix</i>
<i>Guidelines for Teachers</i>	<i>xx</i>
<i>Guidelines for Students</i>	<i>xx</i>

<b>1. Introduction to Engineering Drawing .....</b>	<b>1-30</b>
Unit Specific	1
Rationale	1
Prerequisite	1
Unit Outcomes	1
Introduction	2
1.1 Drawing Instruments	2
1.1.1 Drawing Sheets	2
1.1.2 Drawing Board	4
1.1.3 Mini Drafter	5
1.1.4 T-Square	6
1.1.5 French Curves	7
1.1.6 Drawing Pencils	7
1.1.7 Instrument Box	7
1.2 Lettering	8
1.2.1 Size of Letters	8
1.2.2 Single Stroke Lettering	8
1.2.3 Roman Lettering	9
1.3 Scales	10
1.3.1 Plain Scale	10
1.3.2 Diagonal Scale	11
1.3.3 Vernier Scale	11
1.3.4 Comparative Scale	12
1.3.5 Scale of Chords	12
1.4 Curves and Conic Sections	15

1.4.1	Ellipse	15
1.4.2	Parabola	17
1.4.3	Hyperbola	18
1.4.4	Cycloid	20
1.4.5	Epicycloids	20
1.4.6	Hypocycloid	21
1.4.7	Involutes	22
	Unit Summary	23
	Exercises	23
	Know More	26
	Design Project/Activities	27
	Interesting Facts	28
	Applications (Real Life / Industrial)	28
	Inquisitiveness and Curiosity Topics	28
	Case Study	28
	Suggested Readings / Video Recourses / Learning Websites	29

## 2. Orthographic Projection ..... 31-62

	Unit Specific	31
	Rationale	31
	Prerequisite	31
	Unit Outcomes	31
2.1	Theory of Projection	32
2.2	Types of Projection	32
2.3	Parallel Projection	33
2.4	Perspective Projection	34
2.5	Difference Between Parallel and Perspective Projection	35
2.6	Orthographic Multi View Projection	35
2.6.1	Principal Planes	35
2.6.2	Orthographic Projection Views	36
2.6.3	Orthographic Projection Methods	37
2.6.4	Difference between First Angle and Third Angle Projection	38
2.7	Projection of Points	38
2.7.1	Projection of a Point in First Quadrant	38
2.7.2	Projection of a Point in Third Quadrant	39
2.8	Projection of Lines	42
2.8.1	Projection of a Line Parallel to both the Planes	42
2.8.2	Projection of a Line Perpendicular to HP and Parallel to VP	42
2.8.3	Projection of a Line Perpendicular to VP and Parallel to HP	43
2.8.4	Projection of a Line Inclined to HP and Parallel to VP	44
2.8.5	Projection of a Line Inclined to VP and Parallel to HP	44

2.8.6	Projection of Line Contained by HP and Parallel to VP	45
2.8.7	Projection of Line Contained by VP and Parallel to HP	45
2.8.8	Projectin of Line Contained by VP and HP	45
2.8.9	Projection of a Line Inclined to both HP and VP	46
2.8.10	Projection of a Line Contained by one or both the Planes	48
2.9	Projection of Planes	50
2.9.1	Types of Projection Planes	51
2.9.2	Projection of Planes Perpendicular to H.P. and Parallel to V.P.	51
2.9.3	Projection of Planes Perpendicular to V.P. and Parallel to H.P.	51
2.9.4	Projection of Planes Perpendicular to H.P. and V.P.	52
2.9.5	Projection of Planes Perpendicular to H.P. and Inclined to V.P.	52
2.9.6	Projection of Planes Perpendicular to V.P. and Inclined to H.P.	53
	Unit Summary	57
	Exercises	57
	Interesting Facts	60
	Know More	60
	Applications	61
	Activity	61
	Case Study	61
	Suggested Readings / Video Recourses / Learning Websites	62

### 3. Projection of Solids ..... 63-82

	Unit Specific	63
	Rationale	63
	Prerequisite	63
	Unit Outcomes	63
	Introduction	64
3.1	Classification of Solids	64
3.1.1	Polyhedral	64
3.1.2	Solids of Revolution	66
3.2	Terminology	68
3.3	Projection of Solids in Different Positions	68
3.3.1	Projection of a Solid with its Axis Perpendicular to HP	69
3.3.2	Projection of a Solid with its Axis Perpendicular to VP	69
3.3.3	Projection of a Solid with its Axis Parallel to both HP and VP	70
3.3.4	Projection of a Solid with its Axis Inclined to the VP and Parallel to the HP	71
3.3.5	Projection of a Solid with its Axis Inclined to the HP and Parallel to the VP	71
3.3.6	Projection of a Solid with its Axis Inclined to the HP and VP	72
3.4	Floor Plan	76
	Unit Summary	78
	Exercises	78

Know More	81
Design Activity	81
Interesting Facts	81
Applications	82
Case Study	82
Suggested Readings / Video Resources / Learning Websites	82
<b>4. Sectional Views of Solids .....</b>	<b>83-108</b>
Unit Specific	83
Rationale	83
Prerequisite	83
Unit Outcomes	83
4.1 Introduction to Section of Solids	84
4.2 Types of Sectional Views	84
4.2.1 Full Sections	84
4.2.2 Half sections	85
4.2.3 Offset Sections	85
4.2.4 Revolved Sections	86
4.2.5 Removed Sections	86
4.2.6 Broken-out Sections	87
4.3 Sectional Planes	87
4.3.1 Representation of Sectional Plane	87
4.3.2 Section lining	88
4.3.3 Types of Sectional Plane	88
4.4 True Shape of the Section	89
4.5 Sectioning Techniques	90
4.6 Development of Surfaces of Solids	93
4.6.1 Principle of Development	93
4.6.2 Methods of Development	93
4.6.3 Development of Right Regular Solids	94
Unit Summary	100
Exercises	100
Know More	106
Design Project/Activities	106
Interesting Facts	106
Applications (Real Life / Industrial)	106
Case Study	107
Suggested Readings / Video Resources / Learning Websites	107
<b>5. Isometric Projection .....</b>	<b>109-130</b>
Unit Specific	109
Rationale	109



Prerequisite	109
Unit Outcomes	109
Introduction	110
5.1 Principle of Isometric Projection	110
5.2 Terminology of Isometric Projection	111
5.3 Construction of Isometric Scale	112
5.4 Isometric View	112
5.5 Difference Between Isometric Projection and Isometric View	113
5.6 Isometric Views of Plane Figures	113
5.6.1 Isometric View of a Square	113
5.6.2 Isometric View of Triangle	114
5.6.3 Isometric View of Circle	114
5.7 Isometric Views of Solids	116
5.7.1 Box Method	116
5.7.2 Off-set Method	117
5.8 Conversion of Orthographic Views to Isometric Views	121
5.9 Conversion of Isometric View to Orthographic Projections	123
Unit Summary	124
Exercises	124
Interesting Facts	128
Know More	128
Applications	128
Activity	128
Case Study	129
Suggested Readings / Video Resources / Learning Websites	130

## **6. Overview of Computer Graphics ..... 131-152**

Unit Specific	131
Rationale	131
Prerequisite	131
Unit Outcomes	131
6.1 Computer Aided Design (CAD)	132
6.2 Computer Graphics System	133
6.3 AutoCAD Software	134
6.4 AutoCAD User Interface	135
6.4.1 Application Menu	136
6.4.2 Pull-Down Menus	137
6.4.3 Shortcut Menus	137
6.4.4 Standard Toolbar	138
6.4.5 Coordinate System	138
6.4.6 Crosshairs, Pick-box and Cursor	140

6.4.7	Command window	140
6.4.8	Navigation Bar	141
6.4.9	Quick Access Toolbar	141
6.4.10	Status bar	142
6.4.11	Text window	142
6.5	Function Keys	143
6.6	Select Command	143
6.7	Erase Command	145
6.8	Zoom Command	145
	Unit Summary	146
	Exercises	146
	Know More	148
	Design Project/Activities	149
	Interesting Facts	149
	Applications (AutoCAD Software)	149
	Inquisitiveness and Curiosity Topics	150
	Case Study	150
	Suggested Readings / Video Resources / Learning Websites	151

## **7. Customisation & CAD ..... 153-192**

	Unit Specific	153
	Rationale	153
	Prerequisite	153
	Unit Outcomes	153
7.1	Creating Basic Drawings Using AutoCAD	154
7.1.1	Start AutoCAD Program	154
7.1.2	Setup Layout	154
7.1.3	Set Drawing Units	155
7.1.4	Customize User Interface	155
7.1.5	Set Drawing Limits	156
7.2	Geometrical Constraints	156
7.3	Objects snaps (OSNAP)	159
7.4	Snap and Grid	161
7.5	Ortho Mode	163
7.6	Draw Commands	164
7.6.1	Line Command	164
7.6.2	Circle Command	165
7.6.3	Arc Command	168
7.6.4	Rectangle Command	168
7.6.5	Draw Ellipse and Elliptical Arc Command	169
7.6.6	Polygon Command	170

7.6.7	Polyline Command	170
7.7	Modify Commands	171
7.7.1	Move command	172
7.7.2	Copy Command	172
7.7.3	Offset Command	173
7.7.4	Scale (SC) Command	173
7.7.5	Rotate Command	174
7.7.6	Fillet Command	175
7.7.7	Chamfer Command	176
7.7.8	Trim Command	176
7.8	Dimesioning	177
7.8.1	Linear Dimensions	178
7.8.2	Radial Dimensions	178
7.8.3	Angular Dimensions	178
7.8.4	Ordinate Dimensions	179
7.8.5	Arc Length Dimensions	179
7.8.6	Baseline and Continued Dimensions	179
7.9	Dimension Style manager	182
7.10	Dimension Associate	183
	Unit Summary	186
	Exercises	187
	Know More	189
	Design Project/Activities	190
	Interesting Facts	190
	Inquisitiveness and Curiosity Topics	190
	Applications (Real Life / Industrial)	191
	Case Study	191
	Suggested Readings / Video Resources / Learning Websites	191

## **8. Annotation Layers and 3D Modelling ..... 193-216**

	Unit Specific	193
	Rationale	193
	Prerequisite	193
	Unit Outcomes	193
8.1	Annotation	194
8.1.1	TEXT Pallet	194
8.1.2	Multiline TEXT (MTEXT command)	194
8.1.3	Single Line (TEXT command)	195
8.2	Tolerance in AutoCAD	195
8.3	Layers	197
8.3.1	Create a Layer	197

8.3.2	Rename a Layer	197
8.3.3	Remove a Layer	197
8.3.4	Set the Current Layer	197
8.3.5	Change the Properties Assigned to Layers	197
8.3.6	Layer Properties Manager	198
8.4	Orthographic Projection Views	198
8.5	Section views	199
8.6	Plot Command	200
8.7	Wireframe Modeling	202
8.8	Surface Modeling	203
8.9	Solid Modeling	203
8.9.1	Create Solid Object using EXTRUDE Command	204
8.9.2	Create Solid Objects using REVOLVE Command	205
8.9.3	Create solid objects using SWEEP Command	205
8.9.3	Create solid composites	206
8.10	Parametric modeling and Non parametric modeling	208
	Unit Summary	209
	Exercises	209
	Know More	211
	Design Project/Activities	211
	Interesting Facts	214
	Applications (Real Life / Industrial)	214
	Inquisitiveness and Curiosity Topics	214
	Case Study	215
	Suggested Readings / Video Resources / Learning Websites	215
<b>9.</b>	<b>Projects .....</b>	<b>217-220</b>
	<b>Project 01</b>	<b>217</b>
	Objective	217
	Prerequisites	217
	Procedure	217
	<b>Project 02</b>	<b>217</b>
	Objective	220
	<b>Reference</b>	<b>221</b>
	<b>CO and PO Attainment Table</b>	<b>223</b>
	<b>Index</b>	<b>224</b>