Program Name : Computer & Electronics Program Group
Program Code : CO/CM/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/MU/IS/IC
Semester : First
Course Title : Engineering Graphics
Course Code : 22003

1. RATIONALE

Engineering graphics is the language of engineers. The concepts of graphical language are used in expressing the ideas, conveying the instructions, which helps to do jobs at various places of industry. This course is useful in developing drafting and sketching skills in the student. It covers the knowledge and application of drawing instruments, familiarizes the learner about Bureau of Indian standards related to engineering drawing and to use computer aided drafting software for developing engineering drawings. It attempts to develop the idea of visualizing the actual object or part, on the basis of drawings and blue prints. This course also focuses on developing the imagination and translating ideas into sketches and also the ability to draw and read various engineering curves, projections and dimensioning styles.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Prepare engineering drawings manually using prevailing drawing instruments and computer aided drafting software.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Draw regular geometrical figures.
b. Use drawing codes, conventions and symbols as per IS SP-46 in engineering drawing.
c. Draw the views of given object using principles of orthographic projection.
d. Draw isometric views of given component or from orthographic projections.
e. Draw free hand sketches of given engineering elements.
f. Use computer aided drafting approach to create engineering drawings.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
2	--	4	6	--	--	--	--	--	--	--	50@	20	50~	20	100	40

(**) marks should be awarded on the basis of internal end semester theory exam of 50 marks based on the specification table given in S. No. 9.
*(~²): For the courses having **ONLY practical** examination, the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e. 30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

*Legends: **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit. **ESE** - End Semester Examination; **PA** - Progressive Assessment, #: No theory paper.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

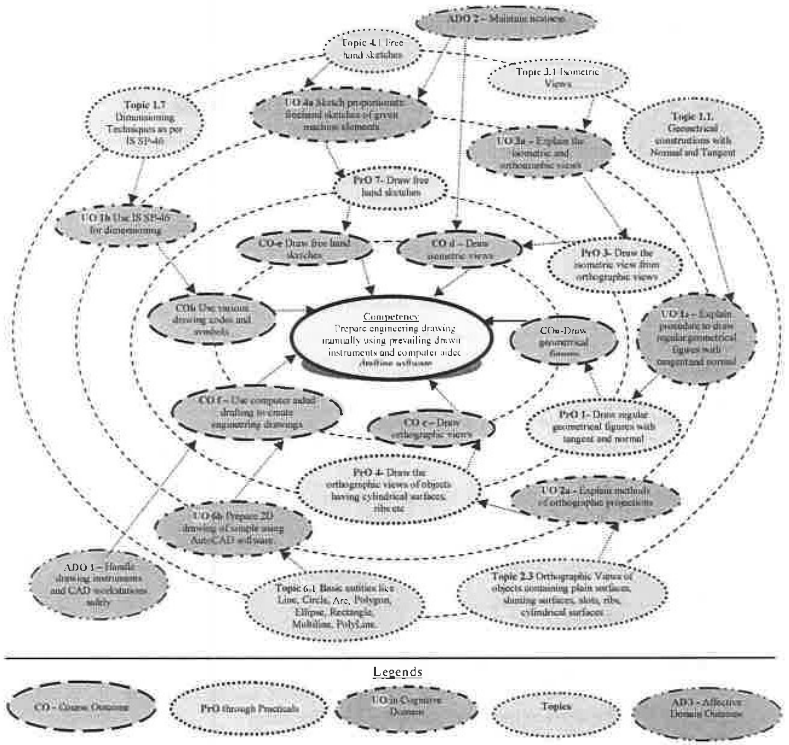

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency. Following practicals (except 1, 2, 3, 4, 24and 25) are to be attempted on A2 drawing sheets.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Sketch Book (Four problems)		

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Draw horizontal, vertical, 30 degree, 45 degree, 60 and 75 degrees lines, different types of lines, dimensioning styles using Tee and Set squares/ drafter. (Problem 1)	I	02
2	Write alphabets and numerical (Vertical only) (Problem 2)	I	02
3	Draw regular geometric constructions and redraw the given figure (Problem 3)	I*	02
4	Draw regular geometric constructions and redraw the given figure (Problem 4)	I	02
Sheet No. 1 (Two problems)			
5	Draw a problem on orthographic projections using first angle method of projection having plain surfaces. (Problem 1)	III	02
6	Draw another problem on orthographic projections using first angle method of projection having plain surfaces. (Problem 1 continued)	III	02
7	Draw a problem on orthographic projections using first angle method of projection having slanting surfaces. (Problem 2)	III	02
8	Draw another problem on orthographic projections using first angle method of projection having slots on slanting surfaces. (Problem 1 continued)	III	02
Sheet No. 2 (Two problems)			
9	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 1)	III	02
10	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 1 continued)	III	02
11	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 2)	III	02
12	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 2 continued)	III	02
Sheet No. 3 (Two problems)			
13	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 1)	IV	02
14	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 1 continued)	IV	02
15	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 2 continued)	IV	02
16	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 2 continued)		
Sheet No. 4 (Two problems)			
17	Draw a problem on Isometric Projection of objects having cylindrical surface by using isometric scale. (Problem 1)	IV	02
18	Draw another problem on Isometric Projection of objects having	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	cylindrical surface by using isometric scale. (Problem 1 continued)		
19	Draw a problem on Isometric Projection of objects having slanting surface by using isometric scale. (Problem 2)	IV	02
20	Draw another problem on Isometric Projection of objects having slot on slanting surface by using isometric scale. (Problem 2 continued)	IV	02
Sheet No. 5 (Two problem)			
21	Draw free hand sketches/conventional representation of machine elements in sketch book such as thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (Problem 1)	V	02
22	Draw free hand sketches/conventional representation of machine elements in sketch book such as thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (Problem 2)	V	02
Sketch Book (One problem)			
23	Problem Based Learning: Given the orthographic views of at least three objects with few missing lines, the student will try to imagine the corresponding objects, complete the views and draw these views in sketch book. (Problem 1)	III, II, V	02
	Total		46

S. No.	Practical Outcomes (PrOs) (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
Computer and Software Based (Nine problems)			
24	Draw basic 2D entities like: Rectangle, Rhombus, Polygon using AutoCAD (Print out should be a part of progressive assessment). (Problem 1)	V*	02
25	Draw basic 2D entities like: Circles, Arcs, circular using AutoCAD (Print out should be a part of progressive assessment). (Problem 2)	V*	02
26	Draw basic 2D entities like: Circular and rectangular array using AutoCAD (Print out should be a part of progressive assessment). (Problem 3)	V*	02
27	Draw blocks of 2D entities comprises of Rectangle, Rhombus, Polygon, Circles, Arcs, circular and rectangular array, blocks using AutoCAD (Print out should be a part of progressive assessment). (Problem 4)	V*	02
28	Draw basic branch specific components in 2D using AutoCAD (Print out should be a part of term work) (Problem 5)	VI*	02
29	Draw basic branch specific components in 2D using AutoCAD (Print out should be a part of term work) (Problem 6)	VI	02
30	Draw complex branch specific components in 2D using AutoCAD (Print out should be a part of progressive assessment) (Problem 7)	VI*	02
31	Draw complex branch specific components in 2D using AutoCAD (Print out should be a part of progressive assessment) (Problem 8)	VI	02
32	Draw complex branch specific components in 2D using AutoCAD	VI	02

S. No.	Practical Outcomes (PrOs) (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
	(Print out should be a part of progressive assessment) (Problem 9)		
	Total		**18**

All practicals are to be performed.

Note

i. *A suggestive list of PrOs is given in the above table, more such PrOs can be added to attain the COs and competency.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Neatness, Cleanliness on drawing sheet	10
2	Uniformity in drawing and line work	10
3	Creating given drawing	40
4	Dimensioning the given drawing and writing text	20
5	Answer to sample questions	10
6	Submission of drawing in time	10
	Total	**100**

Note: *Use above sample assessment scheme for practical exercises 1 to 23.*

S. No.	Performance Indicators	Weightage in %
1	Developing/ using Institute Template	20
2	Selecting relevant set up parameters	05
3	Creating given drawing using relevant Commands.	40
4	Dimensioning the given drawing and writing text using blocks and layers effectively.	15
5	Answer to sample questions	10
6	Submission of digital drawing file/plot in time	10
	Total	**100**

Note: *Use above sample assessment scheme for practical exercises 24 to 32.*

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

i. Follow cleanliness and neatness.
ii. Follow ethics and standards.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Experiment S.No.
1	Drawing Table with Drawing Board of Full Imperial/ A1 size.	All
2	Models of objects for orthographic / isometric projections	1 to 20
3	Models/ Charts of objects mentioned in unit no. 4	-
4	Set of various industrial drawings being used by industries.	All
5	Set of drawings sheets mentioned in section 6.0 could be developed by experienced teachers and made used available on the MSBTE portal to be used as reference/standards.	All
6	Set of various industrial drawings being used by industries. Drawing equipments and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine). b. Set squires (450 and 300-600) c. Protector. d. Drawing instrument box (containing set of compasses and dividers). e. Drawing sheets, Drawing pencils, Eraser. f. Drawing pins / clips	All
7	Drawing equipment's and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine) b. Set squares (45^0 and 30^0- 60^0) c. Protractor d. Drawing instrument box (containing set of compasses and dividers)	1 to 23
8	Interactive board with LCD overhead projector	All
9	CAD Workstation: 2 GB RAM, 320 GB HDD, 17" Screen, 1 GHz. (Minimum requirement)	24 to 32
10	Plotter: Print resolution Up to 1200 x 600 dpi, 16 MB Memory	24 to 32
11	Licensed latest network version of AutoCAD software	24 to 32

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basic elements of Drawing	1a. Prepare drawing using drawing instruments. 1b. Use of IS SP-46.for dimensioning technique. 1c. Use different types of lines. 1d. Draw regular geometrical figures. 1e. Draw figures having tangency constructions.	1.1 Drawing Instruments and supporting material: method to use them with applications. 1.2 Convention of lines and their applications. 1.3 Scale - reduced, enlarged and full size 1.4 Dimensioning techniques as per SP-46 (Latest edition) – types and applications of chain, parallel and coordinate dimensioning. 1.5 Geometrical and Tangency constructions.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		(Redraw the figure)
Unit– II Orthographic projections	2a. Explain methods of Orthographic Projections. 2b. Draw orthographic views of given simple 2D entities containing lines, circles and arcs only. 2c. Draw the orthographic views from given pictorial views. 2d. Use of IS code IS SP-46 for dimensioning technique for given situation.	2.1 Introduction of projections-orthographic, perspective, isometric and oblique: concept and applications.(No question to be asked in examination) 2.2 Introduction to orthographic projection. First angle and Third angle method, their symbols. 2.3 Conversion of pictorial view into Orthographic Views – object containing plain surfaces, slanting surfaces, slots, ribs, cylindrical surfaces. (use First Angle Projection Method Only)
Unit– III Isometric projections	3a. Prepare isometric scale. 3b. Draw isometric views of given simple 2D entities containing lines, circles and arcs only. 3c. Interpret the given orthographic views. 3d. Draw Isometric views from given orthographic views.	3.1 Introduction to isometric projections 3.2 Isometric scale and Natural Scale. 3.3 Isometric view and isometric projection. 3.4 Illustrative problems limited to objects containing lines, circles and arcs shape only. 3.5 Conversion of orthographic views into isometric View/projection.
Unit– IV Free Hand Sketches of engineering elements	4a. Sketch proportionate freehand sketches of given machine elements. 4b. Select proper fasteners and locking arrangement for given situation.	4.1 Free hand sketches of machine elements: Thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (For branches other than mechanical Engineering, the teacher should select branch specific elements for free hand sketching)
Unit– V Computer aided drafting interface	5a. Explain different components of AutoCAD main window. 5b. Open a new/existing file in AutoCAD 5c. Set/edit various parameters in a new/given file.	5.1 Computer Aided Drafting: concept. 5.2 Hardware and various CAD software available. 5.3 System requirement and Understanding the interface. 5.4 Components of AutoCAD software window: Title bar, standard tool bar, menu bar, object properties tool bar, draw tool bar, modify toolbar, cursor cross hair, Command window, status bar, drawing area, UCS icon. 5.5 File features: New file, Saving the file, Opening an existing drawing file, Creating

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		Templates, Quit. 5.6 Setting up new drawing: Units, Limits, Grid, Snap. 5.7 Undoing and Redoing action
Unit– VI Computer aided drafting	6a. Draw basic 2D entities in AutoCAD software. 6b. Prepare 2D drawing of given simple engineering components using AutoCAD software. 6c. Print given drawing using Printer/plotter.	6.1 Draw basic entities like Line, Circle, Arc, Polygon, Ellipse, Rectangle, Multiline, Poly Line. 6.2 Methods of Specifying points: Absolute coordinates, Relative Cartesian and Polar coordinates. 6.3 Modify and edit commands like trim, delete, copy, offset, array, block, layers. 6.4 Dimensioning: Linear, Horizontal, Vertical, Aligned, Rotated, Baseline, Continuous, Diameter, Radius, Angular Dimensions. 6.5 Dim scale variable. 6.6 Editing dimensions. 6.7 Text: Single line Text, Multiline text. 6.8 Standard sizes of sheet. Selecting Various plotting parameters such as Paper size, paper units, Drawing orientation, plot scale, plot offset, plot area, print preview

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER (INTERNAL) DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic elements of Drawing	04	-	02	04	06
II	Orthographic projections	06	-	02	08	10
III	Isometric projections	08	02	02	06	10
IV	Free hand sketches of engineering elements	04	02	-	04	06
V	Computer aided drafting interface	04	02	04	-	06
VI	Computer aided drafting	06	02	04	06	12
Total		**32**	**08**	**14**	**28**	**50**

***Legends**: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

This specification table also provides a general guideline for teachers to frame internal end semester practical theory exam paper which students have to undertake on the drawing sheet.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

a. Student should maintain a separate A3 size sketch book which will be the part of term work and submit it along with drawing sheets. Following assignment should be drawn in the sketch book-
   i. Single stoke vertical Letters and Numbers.
   ii. Type of Lines.
   iii. Redraw the figures. Any three.
   iv. Engineering Curves. One problem for each type of curve.
   v. Orthographic projections. Minimum 5 problems.
   vi. Isometric Projections/Views. Minimum 5 problems.
   vii. Free hand sketches. All types of engineering elements mentioned in Unit no.-4.
   viii. Note- Problems on sheet and in the sketch book should be different.
b. Students should collect Maps, Production drawings, Building Drawings, Layouts from nearby workshops/industries/builders/contractors and try to list
   i. types of lines used
   ii. lettering styles used
   iii. dimension styles used
   iv. IS code referred
c. Name the shapes and curves you are observing around you in real life with name of place and item. (For example ellipse, parabola, hyperbola, cycloid, epicycloids, hypocycloid, involute, spiral helix).
d. Each student should explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each student batch.
e. Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
a. Guide student(s) in undertaking micro-projects.
b. Guide student(s) in fixing the sheet and mini drafter on drawing board.

c. Show video/animation films to explain orthographic and Isometric projection.
d. Demonstrate first and third angle method using model.
e. Use charts and industrial drawing/drawing sheets developed by experienced faculty to teach standard symbols and current industrial/teaching practices.

12. SUGGESTED LIST OF MICRO PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs, and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Isometric views**: Each student of the batch will try to collect at least one production drawings/construction drawings/plumbing drawings from local workshops/builders /electrical and mechanical contractors and try to generate isometric views from the orthographic views given in the drawings.
b. **Isometric views**: Each student of a batch will select a household/industrial real item and will draw its isometric view in the sketch book.
c. **Isometric views**: The teacher will assign one set orthographic projections and ask the student to develop 3D thermocol models of the same.
d. **Computer aided drafting:** Each batch will collect 5 components/circuits/items specific to their branch and draw their orthographic views using AutoCAD software.
e. **Computer aided drafting:** Prepare Logo of your institute/board using AutoCAD and then create a template of your institute for drawing and printing all the drawings prepared in AutoCAD.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Engineering Drawing Practice for Schools and Colleges IS: SP-46	Bureau of Indian Standards	BIS, Government of India, Third Reprint, October 1998; ISBN: 81-7061-091-2
2.	Engineering Drawing	Bhatt, N.D.	Charotar Publishing House, Anand, Gujarat 2010; ISBN: 978-93-80358-17-8
4.	Engineering Drawing	Jolhe, D.A.	Tata McGraw Hill Edu, New Delhi, 2010, ISBN No. 978-0-07-064837-1
5.	Engineering Drawing	Dhawan, R. K.	S. Chand and Company New Delhi, ISBN No. 81-219-1431-0
6.	Engineering Drawing	Shaha, P. J.	S. Chand and Company New Delhi, 2008, ISBN: 81-219-2964-4
7.	Engineering Graphics	Kulkarni, D. M.;	PHI Learning Private Limited-New

S. No.	Title of Book	Author	Publication
	with AutoCAD	Rastogi ,A. P.; Sarkar, A. K.	Delhi (2010), ISBN: 978-8120337831
8.	Essentials of Engineering Drawing and Graphics using AutoCAD	Jeyapoovan, T.	Vikas Publishing House Pvt. Ltd, Noida, 2011, ISBN: 978-8125953005
9.	AutoCAD User Guide	Autodesk	Autodesk Press, USA, 2015
10.	AutoCAD 2016 for Engineers and Designers	Sham ,Tickoo	Dreamtech Press; Galgotia Publication New Delhi, 2015, ISBN: 978-9351199113

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=TJ4jGyD-WCw
b. https://www.youtube.com/watch?v=dmt6_n7Sgcg
c. https://www.youtube.com/watch?v=_MQScnLXL0M
d. https://www.youtube.com/watch?v=3WXPanCq9L1
e. https://www.youtube.com/watch?v=fvjk7PlxAuo
f. http://www.me.umn.edu/courses/me2011/handouts/engg%20graphics.pdf
g. https://www.machinedesignonline.com