

Program Name : Diploma in Mechanical Engineering
Program Code : ME
Semester : Sixth
Course Title : Industrial Hydraulics and Pneumatics
Course Code : 22655

1. RATIONALE

Hydraulic and pneumatic operated machines and equipment are widely used in various industries due to its versatility and adaptability to automation. Mechanical engineering technologists are required to maintain such systems in different segments of industries. This competency needs the knowledge of construction and working of different components of hydraulic and pneumatic systems. This course will give the students, the basic skills and knowledge to use and maintain different types of hydraulic systems and pneumatic systems.

2. COMPETENCY

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

- Use different types of hydraulic and pneumatic systems for engineering applications.

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:

- Identify various components of hydraulic & pneumatic systems.
- Select pump and actuators for given fluid operated system.
- Select appropriate control valves for given fluid operated system.
- Select compressor and appropriate accessories for given fluid operated system.
- Develop different hydraulic circuits for given simple application.
- Develop different pneumatic circuits for given simple application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment



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.

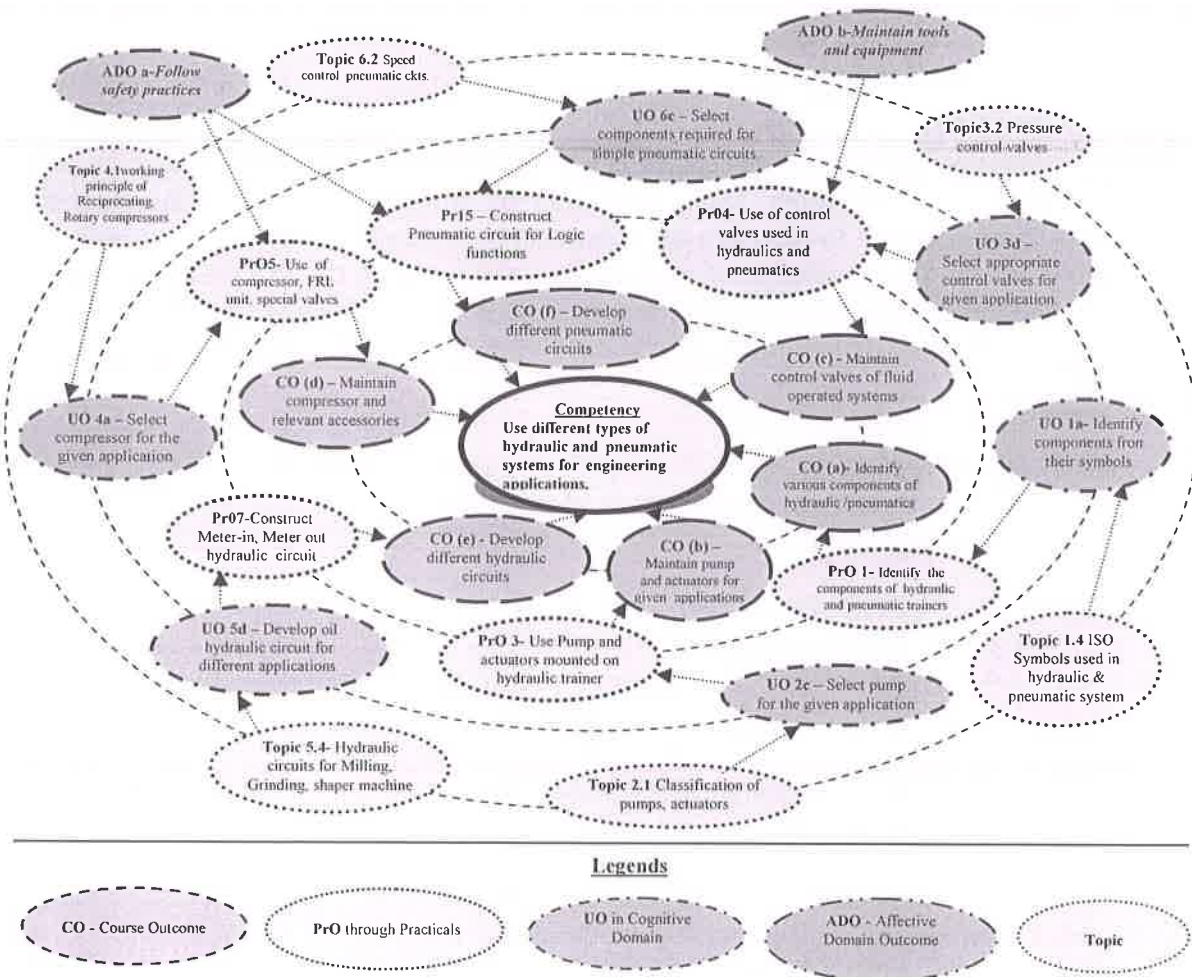


Figure 1 - Course Map

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:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the components of hydraulic and pneumatic trainers.	I	02*
2	List and draw ISO symbols used in hydraulic and Pneumatics.	I	02
3	Use Pump and actuators mounted on hydraulic trainer.	II	02
4	Use of control valves used in hydraulics and pneumatics.	III	02*
5	Use of compressor, FRL unit, special valves and accessories of pneumatics.	IV	02
6	Construct and actuate hydraulic circuit for SAC and DAC, hydromotor	V	02
7	Construct and actuate Meter-in, Meter out hydraulic circuit.	V	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Construct and actuate any suitable sequencing hydraulic circuit.	V	02
9	Develop circuit for simple machine tool applications such as milling machine, shaper machine, grinding machine	V	02*
10	Construct pneumatic circuits using Pneumatic simulation software	V	02
11	Construct and actuate Pneumatic circuit for SAC, DAC, Air motor	VI	02*
12	Construct and actuate speed control Pneumatic circuits.	VI	02
13	Construct and actuate indirect (pilot) control Pneumatic circuit.	VI	02*
14	Develop any suitable sequencing Pneumatic circuit.	VI	02
15	Construct and actuate Pneumatic circuit for Logic functions (AND/OR/TIME DELAY)	VI	02*
16	Construct Hydraulic circuits using Hydraulic simulation software	VI	02*
Total			32

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. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- 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	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
Total		100

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:

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Practice energy conservation.
- d) Work as a leader/a team member.
- e) Follow ethical practices.

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



- 'Organisation Level' in 2nd year
- 'Characterisation 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.

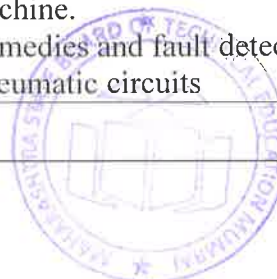
S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Cut sections of pumps, valves, cylinders, motors, accumulators, filters, etc	1,2,3
2	Hydraulic trainer with transparent /actual working components.	1,4,6,7,8,9
3	Pneumatic trainer with transparent/ actual working components.	4,5,12,13,14,15,16
4	Working / actual models of pumps, cylinders, valves, other components	1,2,3
5	Single /Multistage Reciprocating Compressor (pressure 0-10 bar)	4,5,12,13,14,15
6	Hydraulic and pneumatic simulation software	10,16
7	Electro-Pneumatic trainer	16

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit- I Introduction to Hydraulic and Pneumatic Systems	1a. Sketch the labeled general layout of the given type of Hydraulic system. 1b. Identify the given component(s) from their symbols. 1c. List the types of components in the given simple oil hydraulic circuits. 1d. List the desired properties of oil used in the given type of hydraulic system. 1e. Describe the general routine maintenance procedure of the given hydraulic/pneumatic system. 1f. List different Safety precautions required for handling Industrial hydraulics and pneumatics systems.	1.1 General layout of oil Hydraulic Maintain Pneumatic system. 1.2 Applications, Merits, limitations and oil hydraulic systems and Pneumatics systems. 1.3 Properties of fluids, ISO and SAE grades of oil. 1.4 ISO Symbols used in Hydraulic , Pneumatic system. 1.5 Hazard and Safety in Industrial hydraulics and pneumatics
Unit- II Pumps and Actuators	2a. Classify the given types of pumps with justification. 2b. Compare given two types of pumps on the basis of the given criteria. 2c. Select relevant pump for the given application with justification. 2d. Classify given types of actuators with justification. 2e. Describe with sketches the construction of the given actuator(s).	2.1 Classification of pumps. 2.2 Construction and working of Gear, Vane, Screw, piston pumps (axial and radial). 2.3 Performance characteristics and Selection of Pumps. 2.4 Classification of Hydraulic and Pneumatic actuators. 2.5 Construction and working of Linear and rotary actuators

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2f. Select the relevant actuator for the given application with justification. 2g. Describe the routine maintenance procedure of the given type of pump/actuator.	(Motors).
Unit-III Control Valves	3a. Classify the given types of valves with justification. 3b. Describe with sketches the construction of the given valve(s). 3c. Describe the actuation method of the valves for the given application. 3d. Select relevant control valve for the given application with justification. 3e. Describe the routine maintenance procedure of the given type of valve.	3.1 Classification of Control valves. 3.2 Pressure control valves- relief, unloading, sequence, counter balance, pressure reducing valves. 3.3 Direction control valves- Check valve, 2/2,3/2,4/2,4/3,5/2,5/3 D.C. Valves used in Hydraulics and Pneumatics. 3.4 Standard centre positions, Methods of actuation. 3.5 Flow control valves- Non-compensated, Pressure and temperature compensated.
Unit –IV Compressor, Pneumatic Components and Accessories in Fluid System	4a. Select the relevant compressor for the given application with justification 3f. Describe with sketches the construction of the given valve(s). 4b. List various accessories required in the given hydraulic/pneumatics. 4c. Select the relevant accessories for the given type of hydraulic/ pneumatic system with justification.	4.1 Types, construction, working principle of Reciprocating Maintain Rotary compressors. 4.2 Construction, working principle of FRL unit, Dual (twin) pressure valve, Shuttle valve, Quick exhaust valve, Time delay valve. 4.3 Accessories: Oil reservoir, pipes, hoses, fittings, oil filters, air filters, seals and gaskets, intensifiers, accumulators, heat exchanger, muffler.
Unit-V Oil Hydraulic Circuits	5a. Describe with sketches the construction of the given hydraulic circuit 5b. Explain with sketches the working of the given oil hydraulic circuit. 5c. Select the relevant components required for given simple hydraulic circuit with justification. 5d. Develop with sketches the oil hydraulic circuit for the given application. 5e. Describe the routine maintenance procedure of the given oil hydraulic circuit.	5.1 Simple oil hydraulic circuits - Single and Double Acting Hydraulic cylinders, motors. 5.2 Speed control Meter-in, Meter-out, Bleed Off circuit. 5.3 Regenerative, counterbalance, sequencing circuits, synchronizing, two pump unloading. 5.4 Hydraulic circuits for Milling machine, Grinding machine, Shaper machine, slotting machine. 5.5 Remedies and fault detection in Pneumatic circuits



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-VI Pneumatic Circuits	6a. Describe with sketches the construction of the given pneumatic circuit 6b. Explain with sketches the working of the given oil pneumatic circuit. 6c. Select the relevant components required for given simple pneumatic circuit with justification. 6d. Develop with sketches the oil pneumatic circuit for the given application. 6e. Explain Maintenance procedure for Hydraulics and Pneumatics system	6.1 Direct/Indirect Control of Single and Double Acting Air cylinders, motors. 6.2 Speed control circuit for cylinders and motors. 6.3 Sequencing circuits, Logic AND/OR circuits, Time delay circuits, piston continuous back and forth. 6.4 Simple Hydro-pneumatic applications. 6.5 Simple Electro-Pneumatic circuits. 6.6 Remedies and fault detection in Pneumatic circuits 6.7 Maintenance of hydraulic and Pneumatic systems

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

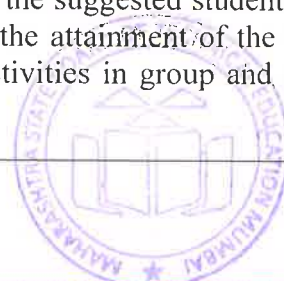
Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Hydraulic and Pneumatic Systems	04	02	02	02	06
II	Pumps and Actuators	08	04	04	04	12
III	Control Valves	12	04	08	04	16
IV	Compressor, Pneumatic Components and Accessories in Fluid system	08	04	04	04	12
V	Oil Hydraulic Circuits	08	00	04	08	12
VI	Pneumatic Circuits	08	02	02	08	12
Total		48	16	24	30	70

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.

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: Students should conduct following activities in group and prepare



reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Prepare journal based on practical performed in Industrial fluid power laboratory. Journal consists of drawing, observations, required measuring tools, equipments, and date of performance with teacher signature.
- b) Power Point Presentation on hydraulic and Pneumatic brakes by group of two/three students. (Duration:10 minutes)
- c) Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students. (Duration:10 minutes)
- d) Prepare report of market survey of suppliers for fluid powered Earth moving equipments like JCB, Mahindra Earth master by group of four students.
- e) Prepare chart on full imperial drawing sheet for ISO Symbols used in hydraulic Maintain pneumatic system by group of two students.
- f) Prepare chart on full imperial drawing sheet for classification of pumps and actuators by group of two students.
- g) Prepare Seminar/presentation on types of oil filters by group of two/three students. (Duration:10 minutes)
- h) Prepare display chart on types of seals and gaskets (actual/ used samples) used in hydraulics.
- i) Prepare visit report of any automobile service station to observe use of pneumatic hand tools.
- j) Prepare visit report of construction sites to observe use of earth moving equipment /Other hydraulic /pneumatic equipments for automation.

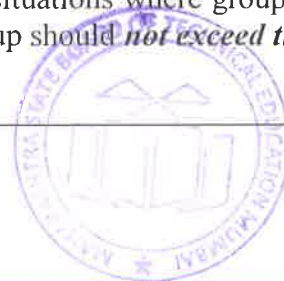
11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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**.
- e) Guide student(s) in undertaking micro-projects.
- f) Before starting practical, teacher should demonstrate the working of instrument.
- g) Instructions to students regarding care and maintenance of measuring equipments.
- h) Show video/animation films to explain functioning of various measuring Instruments
- i) Teacher should ask the students to go through instruction and Technical manuals of instruments

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably 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. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.



The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- a) Market survey of oil used in hydraulic system (Manufacturers, specifications, trade names, cost, packing size) (field-based/ Internet based)
- b) Prepare working model of hydraulic crane using waste injections used by Doctors. (laboratory-based)
- c) Prepare report of agriculture equipments working on hydraulics and pneumatics. (field-based)
- d) Prepare report of specifications of Hydraulic power pack and Pneumatic service unit (FRL Unit) (Internet based)
- e) Collect technical specifications of Gear pumps, Vane pumps/other pumps (Internet based).
- f) Prepare visit report to observe use of Pneumatic system used by Dentist. (field-based)
- g) Prepare visit report on automobile vehicle cleaning service station to observe the hydraulic actuator and system used. (field-based)
- h) Prepare display board by collecting sample of pipes and pipe fittings with specifications of different manufactures. (New/Worn-out) (workshop-based)
- i) Prepare a tabulated summary for types of pipes available in market. (Summary includes type, specification, size range, material, rate and applications). (workshop-based)
- j) Prepare report on specifications, sketches of Linear actuators and mounting methods. (Internet based).
- k) Prepare report on working of hydraulic jack and its system. (Industry application based)
- l) Prepare prototype working model of hydraulically operated hospital bed. (Industry application based)
- m) Prepare demonstration model of telescopic cylinder using PVC pipes. (workshop-based)
- n) Develop working model of automation of bench vice used in carpentry/fitting shop. (workshop-based)
- o) Prepare report of various pneumatic hand tools and its attachments. (Internet based).
- p) Prepare cut section model of any hydraulic/pneumatic component. (laboratory-based)
- q) Prepare report of hydraulic system used in Universal testing machine available in Strength of material laboratory. (laboratory-based)
- r) Prepare report of construction and working of hydraulic press used in nearby machine/fabrication shop. (field-based)
- s) Prepare visit report of service centre for common faults and remedies of hydraulic equipments. (field-based)
- t) Prepare Hydraulic circuit layout with identification of all the components of a hydraulic circuit of heavy earth moving machineries/road construction machineries.
- u) Prepare report of any actual pneumatic system used in low cost automation systems, material handling systems, etc.
- v) Prepare visit report of any one mobile hydraulic system such as in earth moving equipment or any one stationary hydraulic system such as in any machine tool.



13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Oil Hydraulic system- Principles and maintenance	Majumdar, S.R.	McGraw Hill, New Delhi, (2002), ISBN: 9780074637487
2	Pneumatics Systems Principles and Maintenance	Majumdar, S.R.	McGraw Hill, New Delhi, (1996), ISBN-978-0-07-460231-7
3	Fluid Power with applications	Esposito, Anthony	Pearson Education, Inc New Delhi (2003), ISBN 81-7758-580-0
4	Hydraulics and Pneumatics	Stewart, Harry	Taraporewala Publication, (1984) ISBN:978-0672234125
5	Pneumatic Controls	Joji, B.	Wiley India Pub. New Delhi, (2008) ISBN:978-8126515424
6	Hydraulics Maintain Pneumatics A Technicians Maintain Engineers Guide	Parr, Andrew	Butterworth-Heinemann Publisher, (1991), ISBN: 9780080966755
7	Industrial Hydraulics Manual	-----	Vickers Systems International (Company Manual), (2010), ISBN 9780978802202
8	Product Catalogue of FESTO	-----	Company catalogue

14. SOFTWARE/LEARNING WEBSITES

- a) www.cesim.com/simulations
- b) Hydraulic Pumps: https://en.wikipedia.org/wiki/Hydraulic_pump
- c) Hydraulic Pumps: www.hydraulicspneumatics.com/.../HydraulicPumpsM/.../TechZone-HydraulicPumps.
- d) Animation of Hydraulic pumps: <https://www.youtube.com/watch?v=Qy1iV6EzNHg>
- e) Animation of Hydraulic pumps: <https://www.youtube.com/watch?v=pWuxYnqYDnk>
- f) Eaton Pump assembly: <https://www.youtube.com/watch?v=sEVTIRYHoGg>
- g) Video lectures of IIT Faculty: <http://nptel.ac.in/courses/112105047/>
- h) Lecture series and notes by IIT faculty: <http://nptel.ac.in/courses/112106175/>
- i) Pneumatic control valves animation: <https://www.youtube.com/watch?v=XAItnsUcES0>
- j) Control valve symbol generation: <https://www.youtube.com/watch?v=yIot4shcOkE>
- k) Animation of D.C Valve: <https://www.youtube.com/watch?v=jsMJbJQkGTs>
- l) Animation of 4/2,4/3 D.C Valves: <https://www.youtube.com/watch?v=CQPwvWXbV3w>
- m) Animation of Hydraulic cylinder: <https://www.youtube.com/watch?v=bovfDsAYSbc>
- n) Telescopic cylinder animation: <https://www.youtube.com/watch?v=icaqvAtccY>
- o) Pneumatic cylinder: <https://www.youtube.com/watch?v=MmYpzgh6Gok>
- p) Speed control hydraulic circuit: <https://www.youtube.com/watch?v=4eCuPVxezzY>



