

**Programme Name/s : Mechanical Engineering**  
**Programme Code : ME**  
**Semester : Sixth**  
**Course Title : INDUSTRIAL HYDRAULICS AND PNEUMATICS**  
**Course Code : 316363**

**I. RATIONALE**

Hydraulic and pneumatic control systems are widely used in various industries due to their versatility and adaptability to automation. It plays vital role in modernization, semi automation and automation of various industrial equipment. This course will impart the basic skills and knowledge to diploma technician to use and maintain different types of hydraulic and pneumatic systems.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Use different types of hydraulic and pneumatic systems for various engineering applications.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify various components of hydraulic and pneumatic systems from their symbols
- CO2 - Select pump, compressor and actuator for given fluid operated system.
- CO3 - Select appropriate control valves for given fluid operated system.
- CO4 - Select appropriate special components for advanced fluid operated system.
- CO5 - Develop hydraulic and pneumatic circuits for given applications.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH	Paper Duration		Theory				Based on LL & TL				Based on SL		Total Marks	
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
							Max	Min							Max	Min	Max	Min	Max	Min		
316363	INDUSTRIAL HYDRAULICS AND PNEUMATICS	IHP	DSC	4	-	2	-	6		3	3	30	70	100	40	25	10	25#	10	-		-

**Total IKS Hrs for Sem. : Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

**V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT**

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	<p>TLO 1.1 Prepare the general layout of hydraulic and pneumatic systems in given situation.</p> <p>TLO 1.2 Interpret the symbols of given hydraulic and pneumatic components.</p> <p>TLO 1.3 Choose suitable hydraulic fluid as per given requirement based on its properties.</p> <p>TLO 1.4 Explain construction and working of filter with sketch.</p>	<p><b>Unit - I Introduction to Hydraulic and Pneumatic Systems</b></p> <p>1.1 Oil hydraulic &amp; pneumatic system: Basic components and general layout, advantages and disadvantages, comparison between electric, hydraulic and pneumatic systems</p> <p>1.2 ISO Symbols (ISO 1219-1:2012 for symbols and ISO 1219-2:2012 for circuit diagram) used in hydraulic and pneumatic system</p> <p>1.3 Hydraulic Fluid: Functions, types, properties like viscosity, viscosity index and demulsibility, selection of fluids, the effect of temperature and pressure on hydraulic fluid system</p> <p>1.4 Oil filters: Degree of filtration, filtration material, types, construction and working of depth, surface, full flow and proportional filter.</p> <p>1.5 Construction and working of Filter, Regulator and Lubricator (FRL) unit used in pneumatics</p>	<p>Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration Flipped Classroom</p>

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	<p>TLO 2.1 Explain pumps and its classification.</p> <p>TLO 2.2 Compare various types of pumps on the basis of given factors.</p> <p>TLO 2.3 Select pump for the given application.</p> <p>TLO 2.4 Explain compressor and its classification.</p> <p>TLO 2.5 Write constructional details of pneumatic compressors, actuators and control valves with neat sketch.</p> <p>TLO 2.6 Classify various types of actuators with justification.</p> <p>TLO 2.7 Write constructional details of hydraulic actuators with neat sketch.</p> <p>TLO 2.8 Select actuator for the given application with justification</p>	<p><b>Unit - II Pumps and Compressors and Actuators</b></p> <p>2.1 Hydraulic pumps: Classification, construction and working of gear pump (external and Internal), gerotor pumps, vane pump (imbalanced and balanced), screw pump, piston pump (axial and radial), Comparison of pumps</p> <p>2.2 Compressors: Types, construction, working principle of reciprocating and rotary compressors – vane, screw</p> <p>2.3 Selection of pump and compressor for given application.</p> <p>2.4 Hydraulic and pneumatic actuators: Classification, function and applications</p> <p>2.5 Construction and working of linear Actuators: Single acting (spring and gravity return), double acting (Single and double piston rod end) cylinders.</p> <p>2.6 Construction and working of rotary actuators: Gear, gerotor, vane, piston motors, applications</p>	<p>Lecture Using Chalk-Board Model Demonstration Video Demonstrations Presentations Flipped Classroom</p>
3	<p>TLO 3.1 Classify direction control/pressure control/flow control valves</p> <p>TLO 3.2 Write constructional details of given direction Control/pressure Control/flow control valves with neat sketch.</p> <p>TLO 3.3 Select suitable actuation methods of direction control valves as per working condition.</p> <p>TLO 3.4 Compare direction Control/pressure Control/flow control valves on various grounds</p> <p>TLO 3.5 Select appropriate control valve for given application</p>	<p><b>Unit - III Control Valves</b></p> <p>3.1 Direction control valves (DC Valve): Classification, construction, working and applications of poppet valve, sliding and rotary spool valve, 2/2, 3/2, 4/2, 4/3, 5/2, 5/3, DC valves simple and pilot operated check valves (pilot to open, pilot to close) methods of actuation of DC valves, Comparison of DC valves, Selection of standard center position in 3 positions DC valves.</p> <p>3.2 Pressure Control Valve (PC Valve): Classification, construction, working and applications of relief valve (direct and pilot operated), pressure reducing valve (direct and pilot operated), sequence, unloading and counter balance valves. Comparison on various grounds.</p> <p>3.3 Flow control valves (FC Valve): Classification, construction, working and applications of non-compensated, pressure compensated, pressure and temperature compensated flow control valve.</p>	<p>Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration Role Play</p>

<b>Sr.No</b>	<b>Theory Learning Outcomes (TLO's) aligned to CO's.</b>	<b>Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.</b>	<b>Suggested Learning Pedagogies.</b>
4	<p>TLO 4.1 Describe with sketch construction and working of given type special actuators</p> <p>TLO 4.2 Select appropriate type of special valves for given application</p> <p>TLO 4.3 Select appropriate accessories in hydraulic and pneumatic system</p> <p>TLO 4.4 Illustrate the use of various components of Electro Pneumatic system</p> <p>TLO 4.5 Develop ladder diagram for simple hydraulic and pneumatic circuits</p>	<p><b>Unit - IV Advanced Components and Accessories</b></p> <p>4.1 Construction and working of special designs: Telescopic, tandem and rodless cylinder.</p> <p>4.2 Dual pressure valve (AND logic valve), Shuttle valve (OR Logic valve), time delay valve and quick exhaust valve</p> <p>4.3 Accessories: Types, construction and functions of pipes, hoses, fittings, seals and gaskets, accumulators, muffler</p> <p>4.4 Introduction to electro pneumatics, important steps, function of commonly used devices (manually actuated push button switches, limit switches, pressure switches, solenoids, relays, timers, temperature switches, proximity sensors, electric counters), advantages. PLC programming methods.</p> <p>4.5 Development of ladder diagrams of simple hydraulic and pneumatic circuits OR, AND, time delay, sequencing (Basics of PLC are already covered elsewhere)</p>	<p>Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration</p>
5	<p>TLO 5.1 Draw hydraulic and pneumatic circuits using direction control valve for given application.</p> <p>TLO 5.2 Draw hydraulic and pneumatic circuits using pressure control valve for given application</p> <p>TLO 5.3 Draw hydraulic and pneumatic circuits using flow control valve for given application</p> <p>TLO 5.4 Develop hydraulic circuit for specified applications</p> <p>TLO 5.5 Develop pneumatic circuit for specified applications</p> <p>TLO 5.6 Describe maintenance procedure of the given hydraulic and pneumatic system.</p>	<p><b>Unit - V Hydraulic and Pneumatic Circuits</b></p> <p>5.1 Direct and indirect (with pilot valve) triggering of linear and rotary hydraulic and pneumatic actuators</p> <p>5.2 Single and double sequence circuit, two pump unloading circuit, counterbalance circuit, circuit for reduced pressure in part of the system.</p> <p>5.3 Meter in, meter out and bleed off circuits for hydraulic and pneumatic actuators.</p> <p>5.4 Logic OR circuit, logic AND- two hand safety circuit, quick exhaust Circuit</p> <p>5.5 Hydraulic circuits using accumulator as an auxiliary power source, leakage compensator, emergency power source</p> <p>5.6 Position dependent automatic reversal of piston and pressure dependent automatic reversal of piston, time dependent automatic reversal of piston (Time Delay Circuit)</p> <p>5.7 Continuous to and fro motion of double acting cylinder with roller operated valves and solenoid operated valves and limit switches.</p> <p>5.8 Regenerative circuit, rapid feed return circuit, cylinder synchronizing circuits (Series and parallel)</p> <p>5.9 Hydraulic circuits for milling machine, shaper machine and surface grinding machine</p> <p>5.10 Maintenance of hydraulic and pneumatic system – fault finding and remedies</p>	<p>Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit</p>

**VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.**

<b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>	<b>Sr No</b>	<b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>	<b>Number of hrs.</b>	<b>Relevant COs</b>
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<b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>	<b>Sr No</b>	<b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>	<b>Number of hrs.</b>	<b>Relevant COs</b>
LLO 1.1 Identify the components of hydraulic and pneumatic trainers	1	*Identification of hydraulic and pneumatic system components	2	CO1
LLO 2.1 Draw ISO symbols of the components of hydraulic and pneumatic trainers	2	* ISO Symbols of hydraulic and pneumatic components	2	CO1
LLO 3.1 Use pumps mounted on hydraulic trainer.	3	Hydraulic Pumps used in hydraulic system	2	CO2
LLO 4.1 Use compressor and FRL unit mounted on Pneumatic trainer	4	Compressor and FRL unit used in pneumatics	2	CO2
LLO 5.1 Use linear actuators mounted on hydraulic and Pneumatic trainer LLO 5.2 Measure velocity of linear actuators in both the strokes using suitable speed measurement device.	5	*Hydraulic and pneumatic linear actuators	2	CO2
LLO 6.1 Use rotary actuators mounted on hydraulic and Pneumatic trainer LLO 6.2 Measure RPM of rotary actuators using suitable speed measurement device.	6	Hydraulic and pneumatic rotary actuators	2	CO2
LLO 7.1 Prepare hydraulic and pneumatic circuits for actuation of linear and rotary actuators by direct triggering using suitable DC valves. LLO 7.2 Demonstrate hydraulic and pneumatic circuits for actuation of linear and rotary actuators by direct triggering using suitable DC valves following the given procedure.	7	Linear and rotary actuators movement by direct method using suitable DC valves	2	CO3 CO5
LLO 8.1 Prepare hydraulic and pneumatic circuits for actuation of linear and rotary actuators by indirect triggering using suitable DC valves. LLO 8.2 Demonstrate hydraulic and pneumatic circuits for actuation of linear and rotary actuators by indirect triggering using suitable DC valves following the given procedure.	8	*Linear and rotary actuators movement by indirect method using suitable DC valves	2	CO5
LLO 9.1 Prepare circuits using pressure relief and sequence valve LLO 9.2 Demonstrate circuits using pressure relief and sequence valve following the given procedure.	9	*Pressure relief and sequence valve circuits	2	CO3 CO5
LLO 10.1 Prepare speed control circuits for hydraulic actuators (meter in and meter out circuits) LLO 10.2 Demonstrate speed control circuits for hydraulic actuators (meter in and meter out circuits) following the given procedure.	10	* Speed control circuit for hydraulic (meter in and meter out circuits)	2	CO5
LLO 11.1 Prepare speed control circuits for pneumatic actuators. LLO 11.2 Demonstrate speed control circuits for pneumatic actuators following the given procedure.	11	Speed control circuit for pneumatic actuators	2	CO2 CO5

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<b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>	<b>Sr No</b>	<b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>	<b>Number of hrs.</b>	<b>Relevant COs</b>
LLO 12.1 Prepare pneumatic circuits using quick exhaust valve, logic OR, AND, NOT functions. LLO 12.2 Demonstrate pneumatic circuits using quick exhaust valve, logic OR, AND, NOT functions following the given procedure.	12	* Pneumatic circuits involving use of Quick exhaust valve, logic OR, AND functions	2	CO4 CO5
LLO 13.1 Prepare pneumatic circuits using double rod end cylinder /telescopic cylinder. LLO 13.2 Demonstrate pneumatic circuits using double rod end cylinder/ telescopic cylinder following the given procedure.	13	Special purpose actuators pneumatic circuits	2	CO4 CO5
LLO 14.1 Develop ladder diagram for simple circuits	14	Ladder diagram for simple circuits	2	CO4 CO5
LLO 15.1 Diagnose the common faults in hydraulics/pneumatics systems. LLO 15.2 List the corrective measures for identified faults in hydraulics/pneumatics systems.	15	* Simple maintenance of hydraulics/pneumatics	2	CO5
<b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>*' Marked Practicals (LLOs) Are mandatory.</li> <li>Minimum 80% of above list of lab experiment are to be performed.</li> <li>Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul>				

## **VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)**

### **Micro project**

- This course has no SLA allocated but course teacher can optionally allot microprojects to the students to enhance learning. A suggestive list of micro-projects is 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) b. Prepare working model of hydraulic crane using waste injections used by Doctors. c. Prepare report of agriculture equipment working on hydraulic and pneumatics. (field based) d. Prepare visit report to observe use of Pneumatic system used by Dentist. e. Prepare visit report on automobile vehicle cleaning service station to observe the hydraulic actuator and system used. f. Prepare display board by collecting sample of pipes and pipe fittings with specifications of different manufactures.(New/Worn out)

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Hydraulic trainer with transparent /actual working components. Hydraulic power pack with sump tank, capacity: 25 Liters, with Oil level Indicator, hydraulic gear pump: 2.5 LPM at working pressure 35 bar, 1440 RPM, 1 HP, 230V AC, SAC, DAC, pressure control, 3/2, 4/2, 4/3 lever operated, solenoid operated DC Valves, FC Valves, Manifolds	1,2,3,5,6,7,8,9,10,15
2	Pneumatic trainer with transparent/ actual working components, SAC( 40 Ø x 22 x 50 mm Stroke, spring return: 01 No. ) ,DAC( 40 Ø x 22 x 100 mm Stroke: 01 No.), FRL Unit, 2/2, 3/2, 4/2 Hand lever DC Valves, 4/2 Way Double Solenoid valve( 1/4", 24V DC valve), FC Valves , AND, OR Logic gate valves, Manifolds, Hoses	1,2,4,5,6,7,8,11,12,13,15
3	Single /Multistage Reciprocating Compressor (pressure 0-15 bar, Air receiver capacity: 160 liters)	4,5,6,7,8,11,12,13,15
4	Tachometer (mechanical/non contact) for speed measurement (Range 0 to 5000 rpm)	5,6
5	Pneumatic hand tools like nut runner, hand grinder, impact wrench, screw driver, drill	5,6,7,11
6	Actual electropneumatic devices like Limit switches, Pressure switches, Solenoids, Relays, Timers, Temperature switches, Proximity sensors, Electric counters	8,13
7	Cut sections of various pumps of 1 HP showing main parts, 3/2, 4/2, 5/3 lever /push button operated valves, cylinders of stroke length of 150, 200 mm, Unidirectional and Bidirectional Air/ hydraulic motors, accumulators Vertical type, 10- 50 micron filters.	All
8	Working / actual models of pumps, cylinders, valves, other components	All
9	Standard tool kit	All

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R- Level	U- Level	A- Level	Total Marks
1	I	Introduction to Hydraulic and Pneumatic Systems	CO1	8	2	4	4	10

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Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Pumps and Compressors and Actuators	CO2	14	4	6	8	18
3	III	Control Valves	CO3	14	4	6	8	18
4	IV	Advanced Components and Accessories	CO4	11	2	4	6	12
5	V	Hydraulic and Pneumatic Circuits	CO5	13	2	4	6	12
<b>Grand Total</b>				<b>60</b>	<b>14</b>	<b>24</b>	<b>32</b>	<b>70</b>

**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks

**Summative Assessment (Assessment of Learning)**

- End semester assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks.

**XI. SUGGESTED COS - POS MATRIX FORM**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	1	-	1	1			
CO2	3	2	2	2	1	1	1			
CO3	3	2	2	2	1	1	1			
CO4	3	2	2	2	1	1	1			
CO5	3	2	2	2	1	1	1			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

**XII. SUGGESTED LEARNING MATERIALS / BOOKS**

Sr.No	Author	Title	Publisher with ISBN Number
1	Majumdar S.R	Oil Hydraulic system Principles and maintenance	Tata McGraw Hill,1st Edition, ISBN: 9780074637487
2	Majumdar S.R	Pneumatics Systems Principles and Maintenance	Tata McGraw Hill,1st Edition, ISBN-978-0-07-460231-7

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Sr.No	Author	Title	Publisher with ISBN Number
3	Anthony Esposito	Fluid Power with applications	Pearson Education, Inc 2000,7th Edition, ISBN 81- 7758-580-0
4	Harry Stewart	Hydraulics and Pneumatics	Taraporewala Publication,1st Edition, ISBN:978-0672234125
5	Joji B.	Pneumatic Controls	Wiley India Pub., Edition 2014, ISBN:978-8126515424
6	Andrew Parr	Hydraulics & Pneumatics A Technicians & Engineers Guide	Butterworth-Heinemann Publisher,3rd Edition, ISBN: 978-0080966755
7	S.Ilango, V.Soundararajan	Introduction to Hydraulics and Pneumatics	PHI Learning Pvt.Ltd. Delhi, 2nd Edition , ISBN:978-81-203-4406-8
8	D. Stewart	Hydraulic And Pneumatic Power For Production Industrial Hydraulics	Industrial Press INC. 200, Madison Avenue, 1st Edition, New-York 10016.ISBN:978-0831111144
9	Vickers Systems International	Industrial Hydraulics Manual	Vickers Systems International (Company Manual)
10	FESTO	Product Catalogue of FESTO	Company catalogue
11	Open source software	Animation software for hydraulics and pneumatics	Any version freely available

**XIII . LEARNING WEBSITES & PORTALS**

Sr.No	Link / Portal	Description
1	<a href="https://en.wikipedia.org/wiki/Hydraulic_pump">https://en.wikipedia.org/wiki/Hydraulic_pump</a>	Hydraulic Pumps
2	<a href="https://www.youtube.com/watch?v=Qy1iV6EzNHg">https://www.youtube.com/watch?v=Qy1iV6EzNHg</a>	Animation of Hydraulic pumps
3	<a href="https://www.youtube.com/watch?v=pWuxYnqYDnk">https://www.youtube.com/watch?v=pWuxYnqYDnk</a>	Animation of Hydraulic pumps
4	<a href="https://www.youtube.com/watch?v=sEVTIRYHoGg">https://www.youtube.com/watch?v=sEVTIRYHoGg</a>	Eaton Pump assembly
5	<a href="http://nptel.ac.in/courses/112105047/">http://nptel.ac.in/courses/112105047/</a>	Video lectures of IIT Faculty
6	<a href="http://nptel.ac.in/courses/112106175/">http://nptel.ac.in/courses/112106175/</a>	Lecture series and notes by IIT faculty
7	<a href="https://www.youtube.com/watch?v=XAItnsUcES0">https://www.youtube.com/watch?v=XAItnsUcES0</a>	Pneumatic control valves animation
8	<a href="https://www.youtube.com/watch?v=yIot4shcOkE">https://www.youtube.com/watch?v=yIot4shcOkE</a>	Control valve symbol generation
9	<a href="https://www.youtube.com/watch?v=jsMJbJQkGTs">https://www.youtube.com/watch?v=jsMJbJQkGTs</a>	Animation of D.C. Valve
10	<a href="https://www.youtube.com/watch?v=CQPwwWXbV3w">https://www.youtube.com/watch?v=CQPwwWXbV3w</a>	Animation of 4/2,4/3 D.C Valves
11	<a href="https://www.youtube.com/watch?v=bovfDsAYSbc">https://www.youtube.com/watch?v=bovfDsAYSbc</a>	Animation of Hydraulic cylinder
12	<a href="https://www.youtube.com/watch?v=icaqvAtccY">https://www.youtube.com/watch?v=icaqvAtccY</a>	Telescopic cylinder animation
13	<a href="https://youtu.be/SR47RaA1Zdk">https://youtu.be/SR47RaA1Zdk</a>	Pneumatics, Pneumatic Control and Electropneumatic explained - Pneumatics for beginners
14	<a href="https://youtu.be/Alr7EZFYMS4">https://youtu.be/Alr7EZFYMS4</a>	Hydraulics History and documentary (Modern Marvel)

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

