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**AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS** **Course Code : 316347**

**Programme Name/s** : **Automobile Engineering.**

**Programme Code** : **AE**

**Semester** : **Sixth**

**Course Title** : **AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS**

**Course Code** : **316347**

## I. RATIONALE

Hydraulic and pneumatic control systems are extensively used in both the automotive and manufacturing industries due to their versatility and adaptability in automation. Automobile technocrats must be proficient in maintaining these systems. This course is designed to provide students with the knowledge and skills essential to effectively maintain and manage various hydraulic and pneumatic systems in industrial settings.

## 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: Maintain automotive hydraulic and pneumatic systems efficiently.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply principles of fluid mechanics for energy conservation.
- CO2 - Select suitable hydraulic pumps for the given applications.
- CO3 - Maintain hydraulic and pneumatic components used in automobile systems.
- CO4 - Select appropriate accessories for a given fluid-operated systems.
- CO5 - Maintain hydraulic, pneumatic and hydro-pneumatic circuits and systems.

## 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 | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 316347 | AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS | HPC | DSC | 3 | - | 2 | 1 | 6 | 3 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | - | - | 25 | 10 | 150 |

**Total IKS Hrs for Sem. :** 0 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 | TLO 1.1 Define different properties of fluids.<br>TLO 1.2 Classify different fluid flows.<br>TLO 1.3 Classify different pressures.<br>TLO 1.4 List different device for measurement of pressure.<br>TLO 1.5 Determine different parameters by using Bernoulli 's theorem.<br>TLO 1.6 Calculate different Hydraulic Coefficients. | **Unit - I Overview of Fluid Mechanics**<br>1.1 Fluid Fundamentals: Classification of fluids, properties of fluids: specific weight, specific gravity, viscosity. Specifications of hydraulic oil, Pascal 's law, Types of fluid flow- steady, unsteady, laminar, turbulent, one, two and three dimensional flow, uniform and non-uniform flow.<br>1.2 Pressure Measurement: Concept of Intensity of pressure and pressure head. Concept of atmospheric pressure, gauge pressure, vacuum and absolute pressure. Pressure gauges - Piezometer tube, simple and differential manometer. Bourdon's tube pressure gauge<br>1.3 Hydrodynamics: Basic principles of fluid flow, Law of continuity and its applications. Energy possessed by the liquid in motion. Bernoulli's theorem and its applications such as Venturi meter, orifice-meter and Pitot tube. Hydraulic Coefficients: Coefficient of Contraction, Coefficient of Velocity, Coefficient of Discharge and Coefficient of Resistance. Relation between hydraulic coefficients. | Lecture Using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Model Demonstration |
| 2 | TLO 2.1 Explain construction and working of different pumps.<br>TLO 2.2 State significance of NPSH.<br>TLO 2.3 Select pumps on the basis of pressure, discharge, field of application and economy.<br>TLO 2.4 Differentiate the given Positive Displacement pumps. | **Unit - II Hydraulic Machinery**<br>2.1 Centrifugal Pump: Working principle of centrifugal pump and types of casing. Need of priming, Heads, losses and efficiencies of centrifugal pump, Cavitation and Net Positive Suction Head (NPSH), Fault finding and remedies, Pump selection.<br>2.2 Reciprocating Pump: Construction and working of single and double acting reciprocating pump, Coefficient of discharge, positive and negative slip, Air vessels (Functions and Advantages)<br>2.3 2.3 Submersible Pump:Construction, working and application<br>2.4 2.4 Positive Displacement Pumps: Gear type, vane type , plunger type (axial, radial, swash plate and bent axis), Comparison of above pumps for various characteristics and their applications. | Lecture Using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Model Demonstration |

**AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS** **Course Code : 316347**

| 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. |
|---|---|---|---|
| 3 | TLO 3.1 Draw layout of automobile hydraulic and pneumatic system.<br>TLO 3.2 Explain the constructional and working of the given hydraulic and pneumatic actuator with neat sketch.<br>TLO 3.3 Explain hydraulic and pneumatic valves with neat sketch.<br>TLO 3.4 Classify different valves. | **Unit - III Basic Components of Hydraulic and Pneumatic Systems**<br>3.1 General layout of oil hydraulics and pneumatics system.<br>3.2 Hydraulic Actuators-hydraulic cylinders (Single, double and telescopic)-Construction and working, hydraulic motors (gear and piston type)-construction and working.<br>3.3 Pneumatic Actuators-Pneumatic cylinders (single and double acting)-construction and working, air motors (vane and piston type)-construction and working.<br>3.4 Classification of Control valves. Pressure control valves-relief, unloading, sequence, counter balance, pressure reducing valves. 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. Standard centre positions, Methods of valve actuation. Flow control valves- Non compensated, Pressure and temperature compensated. | Lecture Using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Model Demonstration |
| 4 | TLO 4.1 Explain with sketch the functions of the given accessory for hydraulic systems.<br>TLO 4.2 Compare the given accessories of pneumatic/hydraulic systems .<br>TLO 4.3 Select accessories based on Material Compatibility, type of sealing (Static/ dynamic), Shape and Design. | **Unit - IV Accessories of hydraulic and Pneumatic systems**<br>4.1 Hydraulic filters and strainers- Full flow and proportional types, function and working, difference between filters and strainers.<br>4.2 Pneumatic Filters-Screen type and mechanical type, function and working, FRL unit.<br>4.3 Hoses and connectors for Hydraulic and Pneumatic systems- Types, construction and application.<br>4.4 Seal and gasket for hydraulic and pneumatic systems-Types, function and construction of commonly use seals and gasket materials.<br>4.5 Concept of Intensifiers and accumulators. | Lecture Using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Model Demonstration |
| 5 | TLO 5.1 Draw ISO symbols (ISO 1219-1:2012) used in Pneumatic Hydraulic circuits.<br>TLO 5.2 Draw simple hydraulic and pneumatic circuits.<br>TLO 5.3 Draw specified circuit using the given components for the given application.<br>TLO 5.4 Name different components of Hydro-pneumatic systems.<br>TLO 5.5 Write procedure for Maintenance of Hydraulic, Pneumatic and hydro-pneumatic systems.<br>TLO 5.6 Diagnose different faults in hydraulic and pneumatics systems. | **Unit - V Hydraulic and Pneumatic Circuits and systems**<br>5.1 ISO symbols (ISO 1219-1:2012) used in Pneumatic Hydraulic circuits.<br>5.2 Simple Hydraulic circuits: Single and Double Acting Hydraulic cylinders, motors. Speed control circuits: Meter in, Meter out, bleed off, Sequencing circuits Applications of hydraulics circuits-Hydraulic power steering, hydraulic brakes, milling machine, hydraulic press. Electro-hydraulics-concept, principles and applications.<br>5.3 Simple pneumatic circuits: Single and Double Acting Hydraulic cylinders, motors. Speed control circuit, Sequencing circuit and time delay circuit, Application of pneumatic circuits-air brake, low-cost automation in industries, pneumatic power tools (drill, nut runner, hammer and grinder).<br>5.4 Simple hydro-pneumatic circuits and system-Hydro-pneumatic rams, Brake booster of truck/bus, Pin lift of pneumatic mounding machines.<br>5.5 Maintenance of Hydraulic, Pneumatic and hydro-pneumatic systems.<br>5.6 Troubleshooting of hydraulic and pneumatics systems. | Lecture Using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Model Demonstration |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL

**EXPERIENCES.**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Identify various components of available hydraulic brake.<br>LLO 1.2 Check the condition of various components of hydraulic brake.<br>LLO 1.3 Do the necessary remedial action based on condition observed. | 1 | Hydraulic circuit and components of automobile hydraulic brakes relevant to Pascal's law. | 2 | CO1 |
| LLO 2.1 Calculate total energy available at different sections of a pipe layout.<br>LLO 2.2 Verify Bernoulli’s theorem. | 2 | *Measurement of total energy available at different sections of a pipe layout to verify Bernoulli’s theorem | 2 | CO1 |
| LLO 3.1 Measure the manometric head (Hm) at different flow rates<br>LLO 3.2 Calculate overall efficiency of centrifugal pump<br>LLO 3.3 Plot performance characteristics based on the results | 3 | *Determination of overall efficiency of Centrifugal pump using Centrifugal pump test rig | 2 | CO2 |
| LLO 4.1 Identify various components of centrifugal pump<br>LLO 4.2 Check the condition of various components of centrifugal pump<br>LLO 4.3 Do the necessary remedial action based on condition observed. | 4 | Assembly and dismantling of the centrifugal pump to prepare a troubleshooting chart. | 2 | CO2 |
| LLO 5.1 Calculate overall efficiency of reciprocating pump<br>LLO 5.2 Calculate percentage slip of reciprocating pump | 5 | *Determination of overall efficiency and percentage slip of Reciprocating pump using Reciprocating pump test rig | 2 | CO2 |
| LLO 6.1 Identify various components of available reciprocating pump.<br>LLO 6.2 Check the condition of various components of reciprocating pump.<br>LLO 6.3 Do the necessary remedial action based on condition observed. | 6 | Assembly and dismantling of the reciprocating pump to prepare a troubleshooting chart. | 2 | CO2 |
| LLO 7.1 Identify various components of available lubricating oil pump.<br>LLO 7.2 Check the condition of various components of lubricating oil pump.<br>LLO 7.3 Do the necessary remedial action based on condition observed. | 7 | Assembly and dismantling of the lubricating oil pump of car. | 2 | CO2 |
| LLO 8.1 Identify various components of air motor.<br>LLO 8.2 Check the condition of various components of air motor.<br>LLO 8.3 Do the necessary remedial action based on condition observed. | 8 | Assembly and dismantling of the air motor. | 2 | CO3 |
| LLO 9.1 Identify various components of used valve.<br>LLO 9.2 Check the condition of various components of used valve.<br>LLO 9.3 Do the necessary remedial action based on condition observed. | 9 | *Assembly and dismantling of the hydraulic and pneumatic system valves. | 2 | CO3 |
| LLO 10.1 Inspect hydraulic and pneumatic filters used in the system.<br>LLO 10.2 Clean hydraulic and pneumatic filters used in the system.<br>LLO 10.3 Replace hydraulic and | 10 | Service and replacement of the hydraulic and pneumatic filters. | 2 | CO4 |

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| pneumatic filters used in the system if needed. | | | | |
| LLO 11.1 Identify and select leak detection tests.<br>LLO 11.2 Check the effectiveness of seals and gaskets by identifying leaks.<br>LLO 11.3 Do the necessary remedial action based on condition observed. | 11 | *Leak detection test to verify the effectiveness of installed seals and gaskets. | 2 | CO4 |
| LLO 12.1 List ISO symbols used in Pneumatic Hydraulic circuits.<br>LLO 12.2 Draw ISO symbols used in Pneumatic Hydraulic circuits. | 12 | Drawing of the ISO symbols used in pneumatic hydraulic circuits. | 2 | CO5 |
| LLO 13.1 Draw Meter-in and Meter-Out Hydraulic circuits.<br>LLO 13.2 Choose different components for Meter-in and Meter-Out Hydraulic circuits.<br>LLO 13.3 Connect and Test the circuit for the correct operation. | 13 | *Construction and actuatuation of the Meter-in and Meter-Out hydraulic circuits. | 2 | CO5 |
| LLO 14.1 Draw Sequencing Hydraulic circuits.<br>LLO 14.2 Choose different components for Sequencing Hydraulic circuits.<br>LLO 14.3 Connect and Test the circuit for the correct operation. | 14 | *Developement of any suitable sequencing hydraulic circuit | 2 | CO5 |
| LLO 15.1 Draw Sequencing Pilot Control Pneumatic circuits.<br>LLO 15.2 Choose different components for Pilot Control Pneumatic circuit.<br>LLO 15.3 Connect and Test the circuit for the correct operation. | 15 | Construction and actuatuation of the pilot control pneumatic circuit. | 2 | CO5 |
| LLO 16.1 Select a Hydraulic and Pneumatic simulation software.<br>LLO 16.2 Represent the Hydraulic and Pneumatic circuit using the software's graphical interface and connecting the components.<br>LLO 16.3 Execute the simulation to observe the circuit's behavior. | 16 | *Construction of the Hydraulic and Pneumatic circuit using simulation software. | 2 | CO5 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

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

**Assignment**

- Visit a hydroelectric power plant and prepare a report on layout of plant, components of plant.
- Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students. (Duration: 10 minutes)
- Prepare journal based on practical performance in Industrial fluid power laboratory.
- Power Point Presentation on hydraulic and Pneumatic brakes by group of two/three students. (Duration: 10 minutes)
- Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students.

(Duration: 10 minutes)

- Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students. (Duration: 10 minutes)
- Prepare Seminar/presentation on types of oil filters by group of two/three students.(Duration: 10 minutes)

**Micro project**

- Prepare report of market survey of suppliers for fluid powered Earth moving equipment's like JCB, Mahindra Earth master by group of four students.
- Prepare chart on full imperial drawing sheet for ISO Symbols used in hydraulic and pneumatic system by group of two students.
- Prepare display chart on types of seals and gaskets (actual/ used samples) used in hydraulics.
- Prepare visit report of any automobile service station to observe use of pneumatic hand tools.
- Prepare visit report of construction sites to observe use of earth moving equipment /Other hydraulic /pneumatic equipment's for automation.
- Prepare case study report on maintenance of hydraulic brake, air brake, hydraulic jack, and hydraulic power steering.
- Prepare a detailed report based on the range of products, manufacturer and technical specifications of Centrifugal/ reciprocating/ multistage pumps/ submersible pumps/any other pump from the local market or internet.

**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 judicial 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 kit consisting of power pack (motor, pump, tank, filter, breather, pressure relief valve and pressure gauge), Basic components-valves-direction control valve, flow control valve, sequencing valve, bleed off valve, pressure gauge, actuators, accumulators, rigid pipes, hoses and connectors. | 13,14 |
| 2 | Compressor (Two stage -Two-cylinder air cooled, with intercooler and after cooler, receiver mounted,30 to 40 m3/hr,3.5 KW with pressure switch, pressure gauge and safety valve mounted). | 15,16 |
| 3 | Pneumatic trainer kit consisting of compressor, basic components-FRL unit, valves-direction control valve, flow control valve, safety valve, sequence valve, connectors and hoses. | 15,16 |
| 4 | Venturimeter Test-Rig (Venturimeter-Cast iron/Brass/PVC) 25 mm and 50 mm. | 2 |
| 5 | Practical; Set-up of Bernoulli's Theorem (apparatus for verification of Bernoulli's theorem complete with tank). | 2 |
| 6 | Measuring Equipments (Pressure gauges, Stopwatch, etc) | 2,4,6 |
| 7 | Centrifugal pump test rig (Constant Speed-Centrifugal pump, with electric motor, vacuum gauge at suction and pressure gauge on discharge pipe, gate valve on discharge). Motor suitable for main and operating characteristics. | 3 |
| 8 | Centrifugal Pump-1/2 HP (370 W),1400 rpm. | 4 |
| 9 | Maintenance kit (Maintenance tool kit for hydraulic and pneumatic system) | 4,6,7,8 |
| 10 | Hydraulics and Pneumatics Maintenance Tool Kit | 4,6,7,8,9,10,11 |

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 11 | Reciprocating pump test rig (Re-circulating type unit with reciprocating pump and vacuum gauge, pressure gauge at discharge) three speed drive arrangement pulley. | 5 |
| 12 | Reciprocating pump-Max.Flow rate: upto 3728 L/Hr Max. Pressure: upto 150 | 6 |
| 13 | Gear pump of lubrication system of a vehicle. | 7 |
| 14 | Hydraulic and Pneumatic Valves- Direction control valves: Operating pressure min 10 bar Operating pressure max 50 bar, Nominal flow 80 L/min. Flow control valve: Valve size ¼" to 2", Pressure 500 bar. Pressure relief valve: flow rate (60 L/min). Material-Brass, Pressure-35 bar. | 9 |

## 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 | Overview of Fluid Mechanics | CO1 | 8 | 2 | 4 | 6 | 12 |
| 2 | II | Hydraulic Machinery | CO2 | 10 | 4 | 4 | 8 | 16 |
| 3 | III | Basic Components of Hydraulic and Pneumatic Systems | CO3 | 12 | 4 | 6 | 8 | 18 |
| 4 | IV | Accessories of hydraulic and Pneumatic systems | CO4 | 6 | 2 | 2 | 4 | 8 |
| 5 | V | Hydraulic and Pneumatic Circuits and systems | CO5 | 9 | 2 | 6 | 8 | 16 |
| **Grand Total** | | | | **45** | **14** | **22** | **34** | **70** |

## 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
- For Self Learning 25 Marks

**Summative Assessment (Assessment of 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 | 2 | 3 | 3 | 3 | 3 | - | | | |
| CO2 | 3 | 3 | - | 3 | 2 | 3 | 3 | | | |
| CO3 | 3 | 3 | - | - | - | 3 | 2 | | | |
| CO4 | 3 | - | - | - | - | 3 | 2 | | | |
| CO5 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | | | |

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 | Er. R.K. Rajput | A Textbook of Fluid Mechanics and Hydraulic Machines | S. Chand and Company Pvt. Ltd., New Delhi, 1 January 2016 ISBN: 9789385401374 |
| 2 | Dr. R.K. Bansal | Fluid Mechanics and Hydraulic Machines | Laxmi Publications Pvt. Ltd., New Delhi, 1 January 2019 ISBN: 9788131808153 |
| 3 | Dr. P.N. Modi, Dr. S.M. Seth | Hydraulics and Fluid Mechanics including Hydraulic Machines | Standard Book House, New Delhi, 1 January 2019 ISBN: 13: 9788189401269 |
| 4 | R.S. Khurmi, N. Khurmi | A Textbook of Hydraulics, Fluid Mechanics and Hydraulic Machines | S. Chand and Company Pvt. Ltd., New Delhi, 15th Edition, ISBN: 9788121901628 |
| 5 | Modi P.N.; Seth S.M. | Hydraulic and fluid Mechanics | Standard Book House,Delhi,2017 ISBN-13:978-8189401269 |
| 6 | Pippenger, Hicks | Industrial Hydraulics | McGraw Hill Int.Mumbai,3rd Edition ISBN-13:978-0070501409 |
| 7 | Ilango.S. Soundararajan V | Introduction to Hydraulics and Pneumatics | PHI Learning Private Limited, New Delhi, 11 March 2012 ISBN: 978-8120344068 |
| 8 | Esposito Anthony | Fluid Power with Applications | PEARSON Education, Noida, Delhi, 1 January 2013, ISBN-13:978-8177585803 |
| 9 | Sundaram S.K. | Hydraulic and Pneumatic Controls | S. Chand, Pune,2006.1 December 2006 ISBN-13:978-8121926355 |
| 10 | Vickers | Industrial Hydraulics Manuel | Vickers system international Ltd. Pimpri, Pune-411018,1999. ISBN-13:978-0963416209 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://www.youtube.com/watch?v=_bfcdRhY7Rw | Working Principle of Venturimeter |
| 2 | https://www.youtube.com/watch?v=iRdJHPFVHwM | Orifice Meter Working Principle |
| 3 | https://www.youtube.com/watch?v=3zEdtkuNYLU | Pitot Tube Working Animation |
| 4 | https://www.youtube.com/watch?v=IiE8skW8btE | Centrifugal Pump |
| 5 | https://www.youtube.com/watch?v=41vb6T42_Tk | Reciprocating Pump animation |
| 6 | https://www.youtube.com/watch?v=ri5QydTx3AQ | Reciprocating Pump animation |
| 7 | https://www.youtube.com/watch?v=Dim0fLFlFOg&list=PLIMdd_mE4yZGWJ32cgnK2-bs44Gpj81xi | Introduction to Oil Hydraulics and Pneumatics |
| 8 | https://www.youtube.com/watch?v=9cO78SgZkXc | Single Acting Cylinder/Actuator Animation |
| 9 | https://www.youtube.com/watch?v=mDLf7pe_Zug | Telescopic Cylinder/Actuator Animation |
| 10 | https://www.youtube.com/watch?v=sTrEGXXSLSA | Hydraulic Motors Summary of Features |
| 11 | https://www.youtube.com/watch?v=2UoDHqlMGB8 | Types Of Pneumatic Actuators |
| 12 | https://www.youtube.com/watch?v=jbOdnEwUYOw | Flow Control Valves in Hydraulics |
| 13 | https://www.youtube.com/watch?v=LfWTyn8UT5M | Pressure Control Valves |
| 14 | https://www.youtube.com/watch?v=JlYbKgsgrxY | Directional Control Valves |
| 15 | https://www.youtube.com/watch?v=VGWua73ArFs | Types of hydraulic Filters |
| 16 | https://www.youtube.com/watch?v=4BoGenyK45w | Hydraulic accumulators, Classifications, Applications |
| 17 | https://www.youtube.com/watch?v=_EbJvm2T_OU | Industrial Hydraulic Circuit |
| 18 | https://www.youtube.com/watch?v=kbLyD-ATOZ8 | Oil Hydraulic Circuits |
| 19 | https://www.youtube.com/watch?v=JnFOFa7J-Ms | Pneumatic Circuits |

**Note :**

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| Sr.No | Link / Portal | Description |
|---|---|---|
| • Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students | | |

**MSBTE Approval Dt. 04/09/2025** **Semester - 6, K Scheme**