

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: HYDRAULIC AND PNEUMATIC DEVICES
(COURSE CODE: 3362008)

Diploma Programme in which this course is offered	Semester in which offered
Mechatronics	Sixth

1. RATIONALE

The concepts of hydraulics and pneumatics are important and indispensable tools being used in the innovations, circuit design and improvement of engineering processes and devices. Different types of power sources, valves and actuators are essential elements in all the manufacturing industries, specially where automation and control is required. This course is designed to develop underpinning knowledge of hydraulic and pneumatic systems which are widely used for control and other purposes in machine tools, material handling, automobile, marine, elevators, mining, metal processing equipment and other fields. This course also enables the diploma students to operate and troubleshoot different types of hydraulic and pneumatic systems in industries.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire the following competency:

- **Select, operate and maintain hydraulic and pneumatic machineries.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

- Differentiate hydraulic and pneumatic fluid based systems.
- Select and operate various hydraulic and pneumatic elements.
- Operate and maintain hydraulic and pneumatic circuits.
- Operate and maintain various hydraulic and pneumatic devices.
- Troubleshoot various hydraulic and pneumatic installations.
- Operate and maintain hydro-pneumatics circuit diagrams for given applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Fluid Power	1a. Distinguish between hydraulic and pneumatic systems 1b. Compare fluid power transmission with electrical and mechanical transmission. 1c. Describe various laws governing fluid flows. 1d. Select appropriate hydraulic and pneumatic fluid for given application.	1.1 Power transmission modes. 1.2 Hydraulic systems. 1.3 Pneumatic systems 1.4 Laws governing fluid flow: Pascal's law, continuity equation, Bernoulli's theorem, Boyle's, Charles', Gay-lussec' laws. 1.5 Flow through pipes - types, pressure drop in pipes, Working fluids used in hydraulic and pneumatic systems- types, ISO/BIS standards and designations, properties,
Unit– II Hydraulic and Pneumatic Elements.	2a. Select appropriate hydraulic pipe for given application. 2b. Describe the working of hydraulic control valves and actuators 2c. Describe the working of pneumatic control valves 2d. Select, appropriate hydraulic device for given application. 2e. Select, appropriate pneumatic device for given application. 2f. Use and maintain FRL unit in pneumatics. 2g. Select hydraulic and pneumatic accessories with its location on hydraulic and pneumatic system.	2.1 Hydraulic pipes-Types, standards, designation methods and specifications, pressure ratings, applications and selection criteria. 2.2 Pumping theory, Hydraulic Pumps - types, construction, working principle, applications, selection criteria and comparison. 2.3 Hydraulic Actuators, Control valves, Accessories - their types, construction and working 2.4 Pneumatic Pipes - materials, designations, standards, properties and piping layout. 2.5 Air compressors, Air receivers, air dryers, Air Filters, Regulators, Lubricators (FRL unit): their types, construction, working, specifications and selection criteria of following air preparation and conditioning elements 2.6 Pneumatic Actuators and Control valves - types, construction, working, materials and specifications
Unit– III Hydraulic and Pneumatic Circuits	3a. Describe ISO symbols and guiding rules for designing hydraulic and pneumatic system. 3b. Describe the procedure for maintaining basic hydraulic	3.1 ISO symbols used in hydraulic and pneumatic circuits. 3.2 Basic Hydraulic Circuits – types (such as intensifier, regenerative, synchronizing, sequencing, speed control, safety), circuit diagram,

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	and pneumatic circuit based on given system requirements. 3c. Describe function of various components used in above mentioned circuit diagram. 3d. Describe the procedure for maintaining basic hydraulic and pneumatic circuit based on given system requirements.	components, working and applications. 3.3 Basic Pneumatic Circuits – types (such as speed control, two step feed control, automatic cylinder reciprocation, time delay, quick exhaust), circuit diagram, components, working and applications. 3.4 Pneumatic Logic circuit design - classic method, cascade method, step counter method, karnaugh-veitch maps and combinational circuit design.
Unit-IV Hydraulic and Pneumatic Devices	4a. Identify different parts in a given hydraulic and pneumatic device. 4b. Describe function and working of various parts in hydraulic and pneumatic devices.	4.1 Hydraulic and Pneumatic devices – Concept and applications. 4.2 Construction, working principle, major elements, performance variables of: Automotive hydraulic brake, Industrial Fork lift, Hydraulic jack, Hydraulic press, Automotive power steering, Automotive pneumatic brake, Automotive air suspension, Pneumatic drill, Pneumatic gun.
Unit-V Installation, Maintenance and Trouble- Shooting	5a. Describe steps for installation of various hydraulic and pneumatic components. 5b. Identify the various faults in the hydraulic and pneumatic system and the remedial actions for them.	5.1 Installation of hydraulic and pneumatic system. 5.2 Causes and remedies for common troubles arising in hydraulic elements. 5.3 Maintenance of hydraulic systems. 5.4 Causes and remedies for troubles arising in pneumatic elements. 5.5 Maintenance of pneumatic systems
Unit-VI Hydro- Pneumatics	6a. Explain working of hydropneumatic elements. 6b. Compare hydro-pneumatic with hydraulic and pneumatic systems.	6.1 Types, construction, working, circuit diagram and application of following hydropneumatic elements: Air oil reservoir, Hydraulic series check unit, Hydraulic parallel check unit, Hydropneumatic cylinder, Air oil intensifier.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fluid Power	4	4	2	2	8
II	Hydraulic and Pneumatic elements	12	4	6	8	18
III	Hydraulic and Pneumatic Circuits	12	6	6	6	18
IV	Hydraulic and Pneumatic Devices	6	2	6	4	12
V	Installation, Maintenance and Troubleshooting	4	2	2	4	8
VI	Hydropneumatics	4	2	2	2	6
	Total	42	20	24	26	70

Legends: R = Remember, U = Understand, A= Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED EXERCISES/PRACTICALS

The practical should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx. Hours Required
1	I	Preparatory activity: a. Tabulate physical properties of fluid, units and importance in fluid systems.	02
2	II,III	Demonstration of various hydraulic elements: a. Demonstrate model of various hydraulic and pneumatic elements covered in theory syllabus. b. Tabulate all hydraulic and pneumatic elements with name, symbol, specifications and applications. c. Design the hydraulic system circuit using simulation software (based on given input and parameters).	06
3	IV	Performance: a. Design, assemble and operate hydraulic system, based on given simple system requirements (Design mainly include	16

S. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx. Hours Required
		selection and arrangement of elements on hydraulic/pneumatic trainer kit). i. Control of single acting cylinder ii. Control of double acting cylinder iii. Meter-in and meter-out circuits iv. Regenerative Circuit (hydraulic) v. Synchronizing circuits vi. Sequencing circuits vii. Circuit using accumulator (hydraulic) viii. Automatic cylinder reciprocation circuit ix. Quick exhaust circuit (pneumatic) x. Two step feed control circuit (pneumatic) xi. Time delay circuit (pneumatic) xii. Reciprocation of cylinder using pressure switches / limit switches b. Sketch the system diagram with symbols. c. Prepare the list of items and also list the steps of assembly. d. Observe and record the parameters. Change any one parameter and observe the effect on other parameters. Note: Perform minimum 7 practicals from above list.	
4		Seminar presentation: a. Prepare and present seminar topic individually. (Seminar topic has to be given by teacher). b. Download visual aids, videos, contents and other related instructional material for the given case / situation. (Case/situation has to be given by teacher) Present and discuss the same in your class.	4
Total Hours			28

8. SUGGESTED STUDENT ACTIVITIES

- Prepare journals based on practical performed in laboratory.
- Solve as many numerical problems as possible related to theories taught in classroom.
- Prepare/Download a dynamic animation to illustrate the following:
 - Working principle of hydraulic pumps, air compressors.
 - Working principle of hydraulic and pneumatic valves and actuators.
 - Working of different types of hydraulic and pneumatic devices (applications).
- Download the catalogue of hydraulic and pneumatic devices.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- Arrange visit to nearby hydraulic and pneumatic equipment based industries.
- Show video/animation films to explain functioning of hydraulic and pneumatic valves, pumps, actuators and their accessories.
- Arrange expert lectures
- Ask students (in group of 3 to 4) to prepare the ppt on different topics related to hydraulic and pneumatic devices/systems by exploring the internet and present in class seminar.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Author	Title of Book	Publication
1.	Majumdar, S.R.	Oil Hydraulic Systems	Tata Mcgraw-Hill Publication, New Delhi, 3/e, 2013
2.	Majumdar, S.R.	Pneumatic Systems	Tata Mcgraw-Hill Publication, New Delhi, 3/e, 2013
3.	Srinivasan, R.	Hydraulic and Pneumatic Controls	Vijay Nicole Imprints Private, New Delhi, Limited, 2/e, 2008
4.	Jagadeesha, T.	Fluid Power Generation, Transmission and Control	Universities Press (India) Private Limited, New Delhi, 1/e, 2014
5.	Jagadeesha, T.	Pneumatics Concepts, Design And Applications	Universities Press (India) Private Limited, New Delhi, 1/e, 2014
6.	Parr, Andrew	Hydraulic And Pneumatics A Technician's and Engineer's Guide	Jaico Publishing House, New Delhi, 2/e, 2013
7.	Shanmuga Sundaram, K	. Hydraulic And Pneumatics Controls - Understanding Made Easy	S. Chand Company Ltd., New Delhi, 1/e, 2006
8.	Hedges, Charles S.	Industrial Fluid Power Vol. I, II, and III	Womack Educational Publications, 3/e, 2009

B) Major Equipment/ Instrument with Broad Specifications

S. No.	Resource with brief specification.
1	Electro-hydraulic Trainer kit (with/without proportional valves) <u>Components required:</u> Pump, Reservoir, pressure relief valve, check valves, Directional control valves (manual and electrically operated), Flow control valves (fixed and variable), pressure reducing valve, Cylinders, Motor, Accumulator, hosepipes, accessories and setup for electro-hydraulic circuits.
2	Electro-pneumatic Trainer kit <u>Components required:</u> Compressor, pressure relief valve, check valves, Directional control valves (manual, pilot operated and electrically operated), Flow control valves (fixed and variable), pressure reducing valve, Cylinders, Motor, Accumulator, tubes, quick exhaust valve, time delay valve, limit switches, pressure switches, proximity sensors, setup for electro-pneumatic circuits.
4	Working model of pumps, compressors, control valves and actuators.
5	Cut section of various pumps, compressors, valves and actuators.

C) Software/Learning Websites

- <http://www.automationstudio.com/>
- www.boschrexroth.co.in
- <http://www.howstuffworks.com/search.php?terms=hydraulics>
- <http://hyperphysics.phy-astr.gsu.edu/hbase/fluid.html#flucon>

- v. <http://www.youtube.com/watch?v=FVR7AC8ExIM>
- vi. <http://www.youtube.com/watch?v=iOXRoYHdCV0>
- vii. <http://www.youtube.com/watch?v=xxoAm3X4iw0>
- viii. <http://www.youtube.com/watch?v=YxxSmz86zDg>
- ix. <http://www.youtube.com/watch?v=MbKrIieogNc>
- x. <http://www.youtube.com/watch?v=7JuNbHb5NrQ>
- xi. <http://www.youtube.com/watch?v=NakOoD-G0IY>
- xii. <http://www.youtube.com/watch?v=5q7YasmwXCs>
- xiii. <http://www.brighthubengineering.com/fluid-mechanics-hydraulics/>
- xiv. <http://www.hypneu.com/index.html>
- xv. <http://www.nfpa.com/default.aspx>
- xvi. www.festo.com
- xvii. www.nptel.iitm.ac.in
- xviii. Automation Studio 5.0 or higher version
- xix. Festo Fluidsim,
- xx. Hypneu, AUTOMSIM, LVSIM®HYD, LVSIM®PNEU, LogicLab, etc

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. P. S. Patel**, Lecturer, Department of Mechatronics Engineering, B. S. Patel Polytechnic, Kherva.
- **Prof. K. P. Patel**, H.O.D., Department of Mechanical Engineering, B. S. Patel Polytechnic, Ganpat vidhyanagar, Kherva.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. V. Somkuwar**, Associate Professor, Department of Mechanical Engineering,.
- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.