GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-IV

Course Title: Hydraulic & Pneumatic Systems
(Course Code: 4342002)

Diploma program in which this course is offered	Semester in which offered
Mechatronics Engineering	4th Semester

1. RATIONALE

The main objective of this course is to understand the fundamentals of Hydraulic machinery are essential in converting hydraulic energy to mechanical energy and vice-versa. Hydraulic and pneumatic systems are being used for generating required pressure, work, energy and control for desired performance in machine tools, material handling equipment, robots, and automobiles and in equipment related with marine, mining, metal processing. The Mechatronics engineer should be aware of concepts, principles, laws and applications of hydraulic and pneumatic systems. This course has been introduced to develop necessary knowledge and skills in hydraulic and pneumatic systems among diploma students of Mechatronics. Hydraulic turbines are used to meet our day-to-day power demands. Also, different types of pumps are essential equipment in all industries. It also tried understanding hydraulic devices generally used in industries through the course.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Apply the principles of Hydraulic and Pneumatic systems in automation work of machines.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated withtheidentifiedcompetencyaretobedevelopedinthestudentfortheachievementofthefollowingCOs

CO-1	Differentiate hydraulic and pneumatic fluid based systems.
CO-2	Select and operate various hydraulic and pneumatic elements
CO-3	Operate and maintain various hydraulic and pneumatic devices.
CO-4	Troubleshoot various hydraulic and pneumatic installations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	2	3	30	70	25	25	150

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA -

Continuous Assessment; ESE-End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs).Some **POs** marked **'*'**are compulsory, as they are crucial for that particular CO at the' Precision Level' of Dave's Taxonomy related to the 'Psycho motor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	**Preparatory activity:** Tabulate physical properties of fluid, units and importance in fluid systems.	I	02
02	**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 Names , Symbols , Specifications & applications.	II	04
03	Test Performance of centrifugal pump.	II	02
04	Determine the performance characteristics of Pelton wheel turbine under constant head and constant speed.	III	02
05	Identify the components of hydraulic systems	III	02
06	Test the performance of Hydraulic Jack & Hydraulic Lift	III	02
07	Identify the components of pneumatic systems	III	02
08	Test Performance of air compressor.	III	02
09	Control double-acting cylinder, and knowing various types of speed regulation of the piston rod movement of double-acting cylinder.	III	02
10	Sketch & Draw the Symbols of all Hydraulic & Pneumatic Components	II	02
11	Installation of Various Hydraulic & Pneumatic Devices & How to do Maintenance of Particular Devices	IV	02
12	**Seminar presentation:** a. Prepare and present seminar topic individually. (Seminar topic has to be given by teacher).	----	04
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data(which and why)before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required, which are embedded in the Cos and ,ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Experimentation/performance type PrOs (PrOs Number: 2,3,4,5,6,7,8,9,10&11)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
For Demonstration type PrOs (PrOs Number: 1&12)		
1	Knowledge	20
2	Procedure follows	30
3	Observation Skill	20
4	Conclusion/ Summary	10
5	Quality of Report	10
6	Punctuality	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number 1 &12)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labeling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing

Participation	25%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Punctuality	15%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

Experimentation/performance type PrOs (PrOs number 2,3,4,5,6,7,8,9,10 & 11)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Procedure follows	30%	Student follow all the procedure with precaution in a logical order	Student follow all the procedure with some precaution in a logical order	Student follow all the procedure without precaution in a logical order	Student follow all the procedure without precaution in an illogical order
Observation Skill	20%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Conclusion/ Summary	10%	Student concept is mostly clear	Student concept is partly clear	Student concept is somewhat clear	Student concept is not clear
Quality of Report	10%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labelling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing
Punctuality	10%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrO is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Different Turbines	02
2.	Centrifugal pump test rig.	9
3.	All Types of Turbines.	10
4.	Hydraulic prime mover test rig.	11
5.	Working model of hydraulic devices.	12
6.	Working model of Pneumatic devices.	

7. AFFECTIVE DOMAIN OUT COMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the COs mentioned above and PrOs. More could be added to fulfill the development of this course competency.

a. Work as a leader/team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes.(Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's' Affective Domain Taxonomy, 'should gradually increase as planned below:

I. 'Valuing Level' in1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDER PINNING THEORY

Based on the higher level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4to6 UOs at different levels)	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 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 Devices	3a. Identify different parts in a given hydraulic and pneumatic device. 3b. Describe function and working of various parts in hydraulic and pneumatic devices. 3c. Explain the working principle of various pumps, control valves, actuators. 3d. Explain application of various valves: direction control, flow control, pressure control valves. 3e. Describe the working principle and application of hydraulic accumulators with sketches. 3f. Describe the working of the following pneumatic devices with sketches: • Air compressor • Flow control valves: seawater ball valve, Butterfly valve , gate valve(rising and non rising-stem), globe valve , Stop Valve, Three-Way Valve, • Direction control valves	3.1 Hydraulic and Pneumatic devices – Concept and applications. 3.2 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. 3.3 Sketch, constructional features, (constructional and flow diagram with symbols), working and applications of following devices: • Various types of pumps: rotary centrifugal, gear, reciprocating, • Pelton, Kaplan and Francis turbines • Various control valves 3.4 Sketch (constructional and flow diagram with symbols), constructional features, working and applications of following devices: • Air compressor • Flow control valves : seawater ball valve, Butterfly valve , gate valve(rising and non rising-stem), globe valve , Stop Valve, Three-Way Valve, 3.5 Directions control valves • Pressure control elements • Air motor & Air cylinder • Types of signal/switching devices : Pneumatic Proximity Switch (Air Catch Sensor), Pneumatic Valve Actuators - Limit Switch,-Vacuum , Foot , Flow, Pressure Switch
Unit-IV Installation, Maintenance and Trouble Shooting	4a. Describe steps for installation of various hydraulic and pneumatic components. 4b. Identify the various faults in the hydraulic and pneumatic system and	4.1 Installation of hydraulic and pneumatic system. 4.2 Causes and remedies for common troubles arising in hydraulic elements. 4.3 Maintenance of hydraulic systems.

	the remedial actions for them.	4.4 Causes and remedies for troubles arising in pneumatic elements. 4.5 Maintenance of pneumatic systems

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	**Fluid Power**	03	4	5	3	12
II	**Hydraulic and Pneumatic Elements**	10	6	6	8	20
III	**Hydraulic and Pneumatic Devices**	12	12	12	06	30
IV	**Installation, Maintenance and Trouble Shooting**	03	02	02	04	08
Total		**28**	**26**	**23**	**21**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Prepare a chart/presentation to select a particular hydraulic pump for a particular application.
2.	Visit a nearby related industry and prepare a summary of hydro-pneumatic devices used and their specifications.
3.	Solve as many numerical problems as possible related to theories taught in classroom.
4.	Select at least three problems on the manometer and prepare a report containing their solutions.
5.	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).
6.	Download the catalogue of hydraulic and pneumatic devices.
7.	Prepare/Download a dynamic animation to illustrate the following: a) Working principle of hydraulic pumps. b) Working principle of Pneumatic valves. c) Working of different types of hydraulic prime movers.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Hydraulic & Pneumatic Systems being a fundamental subject, teachers are expected to lay

considerable stress on understanding the basic concepts, principles, and applications. For this purpose, teachers are expected to give simple problems in the classroom and provide tutorial exercises to develop the necessary knowledge for comprehending the basic concepts and principles. As far as possible, teaching the subject is supplemented by demonstrations and practical work in the laboratory.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-projects are group-based (groups of 3 to 5). However, **in the fifth and sixth semesters**, 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 must maintain a dated work diary consisting of individual contributions to the project work and give a seminar presentation before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit a micro-project by the end of these semesters to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty could add similar micro-projects in any form (chart/presentation/report/model):

1) Draw a Line Diagram of the water supply & distribution line of your hydraulic lab and indicate the source of major & minor losses in it.
2) Visit the Manufacturers website for Hydraulic Pumps , Collect the Catalog and Select a suitable pump for your home application.
3) Prepare a Demonstration Model of the Hydraulic Devices.
4) Prepare a Demonstration Model of the Pneumatic Devices.
5) Demonstrate various types of speed regulation (throttling) of the piston rod movements of double-acting cylinders with one-way flow control valves are looked at and the effects are observed.
6) Prepare/Download a dynamic animation to illustrate the following:
   a) Working principle of hydraulic pumps.
   b) Working principle of Pneumatic valves.
   c) Working of different types of hydraulic prime movers.
7) Prepare a Chart or PPT on Various Topics Covered in all the Topics & Sub-Topics given by Subject Teacher.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	A Textbook of Fluid Mechanics& Hydraulic Machines	Dr. R.K.Bansal	Lakhsmi publication (P) Ltd
2	Hydraulic & Hydraulic Machines	R.C. Patel & A.D. Pandya	Acharya Book Depot
3	Fundamental of Fluid Mechanics (in SI units)	Dr. D.S. Kumar	Katson Pub. house
4	Fluid Mechanics, Fundamentals, and Applications	Yunus A. Cengel, John M. Cimbala	MC-Graw Hill, Higher Education
5	Hydraulics and Fluid Mechanics, Including Hydraulics Machines	Dr. P. N. Patel, Dr. S. M. Seth	Raj sons Publications Pvt., Ltd.
6	Fluid Mechanics and Hydraulic Machines	R. K. Rajput	S. Chand & Company Ltd.

14. SOFTWARE/LEARNINGWEBSITES

1. https://nptel.ac.in/courses/112105206
2. https://nptel.ac.in/courses/112104117
3. https://nptel.ac.in/courses/112103249
4. https://www.classcentral.com/course/youtube-fluid-mechanics-concept-derivation-videos-53034
5. https://fmc-nitk.vlabs.ac.in/fluid-machinery/exp/centrifugal-pump/index.html
6. https://me.iitp.ac.in/Virtual-Fluid-Laboratory/

15. PO-COMPETENCY-COMAPPING

SemesterIV	Fluid Mechanics and Hydraulic Machinery (4341903)						
SemesterIV	POs						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
Competency &CourseOutcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/development of solutions	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long Learning
Competency	Select, operate and maintain fluid machinery based on fluid laws and characteristics.						
CO-1 Differentiate hydraulic and pneumatic fluid based systems.	3	-	-	-	-	-	3
CO-2 Select and operate various hydraulic and pneumatic elements	2	1	2	3	-	2	3
CO-3 Operate and maintain various hydraulic and pneumatic devices.	3	2	-	2	2	-	2
CO-4 Troubleshoot various hydraulic and pneumatic installations.	2	3	-	3	3	-	2

Legend:'3' for high, '2' for medium, '1' for low, and '-'for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE(GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. R.D Patel (Head Mechanical Engineering Dept.)	B & B Institute of Technology , VV Nagar	9825523982	rakeshgtu@gmail.com
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BOS Resource Persons

Sr. No.	Name and Designation	Department	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS (Chairman HOD Mechanical Engg.)	Government Polytechnic Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel (BOS Member, HOD Mechanical Engg.)	B. & B. Institute of Technology, Vallabh Vidyanagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S. Shah (BOS Member, Principal)	B. V. Patel Institute of Technology, Bardoli	7567421337	Asshah97@yahoo.in