GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-IV

Course Title: Hydraulics and Pneumatics
(Course Code: 4346405)

Diploma programmer in which this course is offered	Semester in which offered
Renewable Energy	Fourth

1. RATIONALE

Diploma holders in this course are required to deal with problems of fluid and use of hydraulics and pneumatics in power generation. For this purpose, knowledge and skills about fluid mechanics and machinery, hydraulics and pneumatics systems are required to be imparted for enabling them to perform above functions.

2. COMPETENCY

- Explain fluid properties, their units and conversion.
- Explain the functions of various components used in hydraulic and pneumatic system.
- Maintain hydraulic and pneumatic system.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Identify fluid properties and their effect on the flow system.
CO-2	Select a hydraulic machine for a particular application.
CO-3	Develop an understating of hydraulic devices frequently used in Industries.
CO-4	Develop an understating of Pneumatic devices and Air Compressor.

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	1	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 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Demonstrate various fluid properties.	I	04
2	Perform a test on the centrifugal pump test rig.	II	04
3	Perform a test on the reciprocating pump test rig.	II	04
4	Perform a test on a hydraulic turbine test rig.	II	04
5	Demonstrate use of different hydraulic devices.	III	04
6	Demonstrate use of different pneumatic devices.	IV	04
7	Performance test on reciprocating air compressor and determine its volumetric efficiency.	IV	04
Total Hours(Hrs)			**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 %
For Demonstration & Experimentation type PrOs		
1	Knowledge	**30**
2	Quality of Report	**30**
3	Participation	**20**
4	Punctuality	**20**
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs 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 with Broad Specifications	PrO. No.
1	Centrifugal pump test rig.	2
2	Reciprocating pump test rig.	3
3	Hydraulic prime mover test rig.	4
4	Model of hydraulic devices.	6
5	Model of Pneumatic devices.	7
6	Air Compressor Test rig	8

7. AFFECTIVE DOMAIN OUTCOMES

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' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING 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)	Topics and Sub-topics
Unit.1 Introduction	1.a Explain the effect of fluid properties on a flow system	1.1 Concept and classification of fluid. 1.2 Properties of fluid i. Density ii. Specific weight iii. Specific volume iv. Specific gravity v. Viscosity vi. Surface tension vii. Cohesion & Adhesion viii. Capillarity ix. Bulk modulus of elasticity x. Vapor Pressure 1.3 Simple numerical examples.

Unit-II **Hydraulic Machines**	2.a Explain the construction and working of hydraulic pumps. 2.b Estimate performance parameters of a given centrifugal and reciprocating pump. 2.c Explain the construction and working of the hydraulic turbine.	2.1 Concept, classification, and application of pumps. 2.2 Construction, working, and application of centrifugal pump. i. Types of impeller and casings. ii. Multistage. iii. Priming. iv. Minimum suction depth. 2.3 Construction, working, and application of reciprocating pump. i. Single acting pump ii. Double acting pump iii. Air vessel 2.4 Numerical on a reciprocating and centrifugal pump. 2.5 Concept of gear pump and vane pump. 2.6 Layout and features of a hydroelectric power plant. 2.7 Classification, construction, working principle, and applications of turbines: i. Pelton wheel turbine ii. Francis turbine iii. Kaplan turbine 2.8 Types, construction, and working of draft tubes.

Unit 3 HYDRAULICS ELEMENTS AND DEVICES	3.a Explain the construction, working, and application of hydraulic devices.	3.1 Types, sketch, working, specifications, symbols and applications of hydraulic and Pneumatic elements like: i. Cylinder, ii. Valve, iii. Manifolds, etc. 3.2 Concepts of Hydraulic devices 3.3 Construction, working, and application of: i. Hydraulic press ii. Hydraulic accumulator iii. Hydraulic ram iv. Hydraulic coupling v. Hydraulic intensifier.
Unit IV **Air Compressor & Components of Pneumatic Systems.**	4.a Explain the principle, construction, and working of Air Compressor. 4.a Explain the principle, construction, and working of Pneumatic Systems.	4.1 Concepts, classification, and applications. 4.2 Construction and working of Reciprocating air compressor, Centrifugal air Compressor, Axial air Compressor 4.4 Air cylinder – types, function, single acting, double acting, rotating, non-rotating, piston type, diaphragm type, tandem cylinder, double ended cylinder, duplex cylinder. 4.5 Air filter, regulator and lubricator – their necessity in pneumatic circuit.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction	4	3	4	-	7
2	Hydraulic Machines	10	8	6	14	28
3	Hydraulics Elements And Devices	8	4	7	10	21
4	Air Compressor & Components of Pneumatic Systems.	6	4	5	5	14

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 related to Fluid Properties.
2	Prepare a chart/presentation to select a particular pump for a particular application.
3	Prepare a chart/presentation to select a particular hydraulic pump for a particular application.
4	Identify any one hydraulic pump and one prime mover available in the market in a group of five students with detailed specifications and current prices.
5	Visit a nearby related industry and prepare a summary of hydro-pneumatic devices used and their specifications.
6	Select at least two problems to determine the power/efficiency of the Reciprocating and Centrifugal pump and prepare a report containing their solutions.
7	Prepare a chart/presentation to select a particular air compressor for a particular application.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	**Unit Title**	**Strategies**
I	**Introduction**	○ Real-life examples, Demonstration of natural systems, Movies/Animations. ○ Numericals, Massive Open Online Courses (MOOCs).
II	**Hydraulic Machines**	
III	**Hydraulics Elements And Devices**	
IV	**Air Compressor & Components of Pneumatic Systems.**	

12. SUGGESTED PROJECT LIST

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 the semester 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. Compare the following liquids concerning their density (for the same mass, compare the volume) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
2. Compare the following liquids concerning their viscosity (for the same temperature, compare the velocity) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
3. Calculate the water weight when your home's water tank is completely filled with water.

4. Prepare a demonstration model of the hydraulic devices.
5. Gather information on prime movers of different hydroelectric power plants in Gujarat.
6. Select a pump for a coolant recirculation in a lathe machine, garage pump for car washing, Bore well pump, pump at a service station, pump used in water coolers, or pump in a purified water filter system with justification.
7. Download/collect a catalogue of pump manufacturers like Kirloskar, Shakti, Jyoti, Lubi, KSB, Havells, etc., and compare their parameters.
8. Prepare any non-Newtonian fluid and compare its characteristics with Newtonian fluid.
9. Collect and analyze technical specifications of Reciprocating / Rotary Air Compressors from manufacturers' websites and other resources.
10. Make a PowerPoint presentation on the latest industry trends in turbines

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	Fundamental of Fluid Mechanics (in SI units)	Dr. D.S. Kumar	Katson Pub. house
3	Fluid Mechanics and Hydraulic Machines	R. K. Rajput	S. Chand & Company Ltd.
4	Hydraulic and Pneumatic Control	K Shammuga	S. Chand & Company Ltd.
5	Pneumatic systems Principles and maintenance	S.R Majumdar	Tata McGraw – Hill.

14. SOFTWARE/LEARNING WEBSITES

1. https://www.me.psu.edu/cimbala/learning/fluid/fluid_prop/fluid_property.htm
2. https://www.sciencedirect.com/topics/engineering/fluid-property
3. https://www.harsle.com/hydraulic-machine-working-principle-and-classification
4. https://engineeringdiscoveries.com/hydraulic-turbine-working-types-advantages-and-disadvantages/

5. https://www.machinerylubrication.com/Read/31732/understanding-hydraulic-accumulators
6. https://www.youtube.com/watch?v=MOJuQd44HEQ
7. https://www.youtube.com/watch?v=8ynNDGenYAw
8. https://www.youtube.com/watch?v=wCPhmJKlHGc

16. PO-COMPETENCY-CO MAPPING:

Semester IV	Hydraulics and Pneumatics (Course Code:4350304)						
	POs						
Competency & Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	Basic & Discipline specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability &	Project Management	Life-long Learning

					environment		
Competency	Maintain hydraulic and pneumatic system based on various fluid properties.						
CO-1 Identify fluid properties and their effect on the flow system.	3	-	-	-	-	-	3
CO-2 Select a hydraulic machine for a particular application.	2	3	-	3	3	-	2
CO-3 Develop an understating of hydraulic devices frequently used in Industries.	2	-	2	2	2	-	2
CO-4 Develop an understating of Pneumatic devices and Air Compressor.	2	-	2	2	2	-	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.				
2.				
3.	Mrs. Jikisha R. Patel Lecturer	Government Polytechnic, Himatnagar	9824063572	jigishapreksha@gmail.com
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