GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Hydraulic & Pneumatic Systems
(Course Code: 4342303)

Diploma programme in which this course is offered	Semester in which offered
Plastics Engineering (Sandwich Pattern)	4th Semester

1. RATIONALE

As Diploma Plastic engineer has to supervise operations and maintenance of various molding machines like injection molding, blow molding, thermoforming, extruder and rotational molding, this competency requires the knowledge of construction and working of different components of hydraulic and pneumatic systems. The course deals with various types of Hydraulic components, Valves, Accessories, Pumps, Motors etc, also deals with Pneumatic components. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Operate various hydraulic, pneumatic & auxiliary components.
- Identify and solve various Hydraulic and Pneumatic problems.
- Designing lay-out of hydraulic & pneumatic circuits to provide working force to the machine moving components.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

- Use & Interpret various symbols used in hydraulic systems.
- Operate different types of valves used in hydraulic systems.
- Maintain different valves and auxiliaries.
- Develop efficient hydraulic circuits for simple application.
- Operate and maintain the pneumatic and hydraulic system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the* ***PrOs*** *marked* ***'*'*** *are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Draw graphical symbols used in Hydraulic & Pneumatic.	I	2
2	Demonstrate application of Pascal's law in hydraulic system.	I	2
3	Select various accessories and find their uses in hydraulic system.	II	2
4	Demonstrate use of directional control valves.	III	4
5	Demonstrate use of pressure control valves.	III	4
6	Apply use of pressure intensifier.	III	2
7	Demonstrate application of flow control valves.	III	2
8	Select appropriate pump from various types of pumps.	IV	2
9	Operate and maintain hydraulic motors.	IV	2
10	To connect and interpret injection control circuit.	V	2
11	To connect and interpret clamp control and reciprocating screw circuits.	V	2
12	To operate single stage air compressor.	VI	2
	Total		28

Note

- *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 suggestive list.*
- *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.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Preparation of experimental setup.	20
2	Operate the equipment setup or circuit.	20
3	Follow safe practices measures.	10
4	Record observations correctly.	20
5	Interpret the result and conclude.	30
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 usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Hydraulic Jack	2
2	Hydraulic Valves : Direction control valve, Pressure control valve & Flow control valves, Cartridge valve	4,5,7
3	Pressure Intensifier & Accumulators	3,6
4	Hydraulic Pump & Motor (Gear type, Vane type, Radial Piston type)	8,9
5	Hydraulic Trainer Kit	10,11
6	Air Compressor (Single acting, Double acting)	12
7	Pneumatic Trainer Kit	12

7. AFFECTIVE DOMAIN OUTCOMES

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

- Work as a leader/a team member.
- Follow ethical practices.
- Observe safety measures.
- Practice good housekeeping.
- Practice environmental friendly methods and processes.

The ADOs are best developed through the 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:

- 'Valuing Level' in 1st year
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I Basic Concepts of Hydraulics	1a. Describe important terms related to hydraulics	1.1 Introduction & Definitions of important terms like Hydraulics, Pressure, Flow, Force, Vacuum etc.

	1b. Apply Pascal's law in hydraulic application 1c. Identify various hydraulic symbols 1d. Identify purposes and characteristics of hydraulic oil	1.2 Pascal's Law and its Application to Hydraulics 1.3 Bernoulli's Principle 1.4 Hydraulic Jack 1.5 Hydraulic Symbols 1.6 Advantages and Disadvantages of Hydraulic System. 1.7 Hydraulic Oil 1.7.1 Purpose of Hydraulic Oil 1.7.2 Ideal Characteristics of Hydraulic Oil 1.7.3 Maintenance of Hydraulic Oil
Unit– II Accessories of Hydraulic System	2a. Classify various connectors 2b. Describe pressure gauge 2c. Classify packings and seals 2d. Compare working of filter and strainers	2.1 Connectors 2.1.1 Steel pipe 2.1.2 Tubing 2.1.3 Hose 2.1.4 Fittings 2.2 Pressure Gauges 2.3 Packing & Seals- Types & applications 2.4 Filters & Strainers 2.5 Hydraulic Tank & its maintenance
Unit– III Hydraulic Valves And Auxiliaries	3a. Describe working of various valves 3b. Select suitable hydraulic valve 3c. Identify need for pressure intensifier 3d. Describe working of accumulators	3.1 Directional Control Valves • Check valve – Ball type, Poppet type, pilot operated • Two way valve • Three way valve • Four way valve 3.2 Decompression valve 3.3 Pressure Control Valves • Relief valve – Simple and balanced piston type • Unloading valve • Sequence valve • Counterbalance valve • Pressure reducing valve 3.4 Pressure componsated Flow Control Valves 3.5 Cartridge Valves- Introduction & application 3.6 Servo & Proportional Valves- Introduction & Applications 3.7 Pressure Intensifiers- Single stage & two stage 3.8 Accumulators – Principle & working

		• Gravity type • Spring loaded • Gas loaded – Separator, non-separator and bladder type 3.9 Pressure switches
Unit – IV Hydraulic Pumps and Motors	4a. Identify various pump specifications 4b. Describe working of various pumps 4c. Identify various pump problems and its rectification 4d. Describe various hydraulic motors	4.1 Pump Specifications 4.2 Construction & Working of 4.2.1 Gear Pump 4.2.2 Vane Pump 4.2.3 Radial Piston Pump 4.3 Pump Maintenance & Trouble Shooting 4.4 Hydraulic Motor Specifications 4.5 Construction & Working of 4.5.1 Gear Motor 4.5.2 Vane Motor 4.5.3 Radial Piston Motor 4.6 Servo Motor-Construction & Working
Unit – V Hydraulic Circuits in Injection molding machine	5a. Describe working of various hydraulic circuit 5b. Identify application of hydraulic circuit 5c. Apply hydraulic circuit 5d. Solve hydraulic problems	5.1 Clamp Control Circuit 5.2 Injection Control Circuit 5.3 Reciprocating Screw Circuit 5.4 Oil Filtration Circuit 5.5 Deceleration Circuit 5.6 Pre-fill Circuit 5.7 Hydraulic Motor Circuit 5.8 Hi-Low Pump Circuit 5.9 Over view of Electro-Hydraulic Circuit.
Unit – VI Pneumatic System	6a. Identify components of pneumatic system 6b. Classify various air compressors 6c. Describe stages of air treatment 6d. Draw pneumatic circuit for plastic processing machine 6e. Apply hydraulic circuit 6f. Compare hydraulic and pneumatic system	6.1 Pneumatic system introduction 6.2 Comparison with Hydraulic System 6.3 Air Compressors: 6.3.1 Single Acting 6.3.2 Double Acting 6.4 Components of Pneumatic System 6.5 Air receiver and pressure control 6.6 Stages of Air Treatment 6.6.1 Inter-cooler 6.6.2 Lubricator 6.6.3 Filter 6.6.4 Air dryer 6.7 Pneumatic Circuit for Plastic Processing Machine

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

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	Basic Concepts of Hydraulics	8	4	6	4	14
II	Accessories of Hydraulic System	5	3	4	0	7
III	Hydraulic Valves And Auxiliaries	12	7	7	7	21
IV	Hydraulic Pumps and Motors	5	2	3	2	7
V	Hydraulic Circuits in Injection Molding Machine	8	0	7	7	14
VI	Pneumatic System	4	3	4	0	7
Total		42	19	31	20	70

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Students will prepare chart of different hydraulic symbols, Hydraulic/Pneumatic Circuit etc.
- Students will collect information related to troubleshooting of various hydraulic & Pneumatic problems in Plastic Processing machines.
- Students will collect information like animations on internet for understanding functioning of various hydraulic and pneumatic components through internet.
- Students will visit nearby industry & check functions of various Hydraulic & Pneumatic components & prepare data sheet for same.
- Students will prepare working model for various Hydraulic/Pneumatic components.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4 means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- About 20% of the topics/sub-topics which are relatively simpler or descriptive in nature is to be given to the students for self-learning, but to be assessed using different assessment methods.
- With respect to section No.11, teachers need to ensure to create opportunities and provisions for co-curricular activities.
- Guide students on how to address issues on environment and sustainability.
- Guide students for using data sheet of different components.
- Ask students to go through instructions & technical manuals of machine/device.
- Demonstrate working model of different hydraulic and pneumatic device in Class/Lab.
- Show video/animation films depicting working principles, constructional features and maintenance procedures of different hydraulic and pneumatic devices and systems.
- Visit to nearby industries/ suppliers shop.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive 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:

- Make Survey for Various types of Oils used in Hydraulic systems.
- Prepare a working model of hydraulic components/part.

- Prepare a chart for symbols used in Hydraulics & Pneumatic system.
- Prepare Hydraulic circuit layout with identification of all components for actual application used in industries.
- Prepare cut section models for any hydraulic/pneumatic component.
- Prepare comparison charts for various pipes/tubes/hose. (Including manufacturer, specifications, size, material of construction, cost, durability, applications etc.)

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Oil Hydraulic System-Principles & Maintenance	Majumdar S.R.	Publication: McGraw Hill, New Delhi Year:2002 ISBN: 9780074637487
2	Pneumatic Systems-Principles & Maintenance	Majumdar S.R.	Publication: McGraw Hill, New Delhi Year:1996 ISBN: 9780074602317
3	Hydraulics and Pneumatics: A Technician's and Engineer's Guide	Andrew Parr	Publication: Butterworth-Heinemann Year: 2011 ISBN: 978-0080966748
4	Injection molding theory and practice	Irvin I. Rubin	Publication: Wiley Year:2014 ISBN: 978-81-265-4576-6
5	Injection molding machine	A.Whelan	Publication: Elsevier applied science Year: 1984 ISBN: 0-85334-245-8
6	Industrial Hydraulics Manual	----	Vickers Systems International (Company Manual) Year:2010 ISBN: 9780978802202

14. SOFTWARE/LEARNING WEBSITES

- https://www.cesim.com/simulations
- https://nptel.ac.in/courses/112106175
- https://nptel.ac.in/courses/112105047
- https://www.youtube.com/watch?v=KM3ivQL6W6w
- https://www.youtube.com/watch?v=y2DM1iSNre0
- https://www.youtube.com/watch?v=xLc70lxQpcU
- https://www.e4training.com/simulate/index.php
- https://play.google.com/store/apps/details?id=com.engadven.simulate&hl=en&gl=US
- http://www.eaton.in/EatonIN/ProductsServices/Aerospace/Hydraulicsystem/index.htm
- www.boschrexroth.com
- https://www.eaton.com/in/en-us.html?percolateContentId=post%3A1

15. PO-COMPETENCY-CO MAPPING

Semester III	Plastic Materials - I (Course Code: 4342303)									
	POs and PSOs									
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**	**PSO 1** An ability to apply principles of material selection, product & mold/die design and development in plastic engineering.	**PSO 2** An ability to conduct safe and environment friendly manufacturing and recycling of plastic products.	**PSO 3** (If needed)
Competency										
Operate various hydraulic, pneumatic & auxiliary components	2	2	1	3	1	-	1	-	-	
Identify and solve various Hydraulic and Pneumatic problems.	2	3	3	2	1	1	2	1	1	
Designing lay-out of hydraulic & pneumatic circuits to provide working force to the machine moving components	2	3	3	2	2	2	2	2	-	
Couse Outcomes (COs)										
Use & Interpret various symbols used in hydraulic systems.	3	2	1	1	-	1	1	1	-	
Operate different types of valves used in hydraulic systems.	2	2	2	3	1	1	2	2	-	
Maintain different valves and auxiliaries	2	2	3	2	2	1	2	1	2	
Develop efficient hydraulic circuits for simple application	2	1	3	3	1	2	2	2	1	

Operate and Maintain the pneumatic and hydraulic system.	3	2	2	2	2	1	3	2	1	

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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