GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Mechanical (I.C.Engine & Automobile Engineering)

Subject Code : ME02080061

Subject Name : Hydraulic & Pneumatic System in Automotive Vehicles

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Nil
Rationale:	All automotive vehicles are equipped by hydraulic and pneumatic systems. Hence the fundamental knowledge of hydraulic and pneumatic systems is most essential for an automobile engineer. This course will help the students to get fundamental knowledge in working of various types of pumps, motors, air compressors and their different associative systems. Knowledge of this course will also be helpful to the students in recent advancements in electro pneumatics, hydro-pneumatic suspension, air brake and other associative systems.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Understand the concept of fluid properties, types of hydraulic fluids, and basic working of systems	Remembering, Understanding
2	Gain knowledge on hydraulic components' construction, working, and maintenance	Understanding, Applying, Analyzing
3	Understand the operation of pneumatic systems and their integration in automotive systems	Remembering, Understanding, Applying
4	Study and analyze advanced systems (hydro-mechanical servo, electro-pneumatics, etc	Analyzing, Evaluating, Creating
5	Apply troubleshooting and maintenance strategies for hydraulic and pneumatic systems	Applying, Analyzing, Evaluating

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Unit 1: Introduction to Fluid Properties, Hydraulic Fluids, and Hydraulic and Pneumatic Systems** • Understanding Fluid Mechanics: Types of fluids, properties of fluids (density, viscosity, etc.), and fluid behavior. • Hydraulic Fluids: Types of hydraulic fluids, characteristics, selection criteria, and applications in automotive vehicles. • Hydraulic and Pneumatic Systems: Basic concepts, differences, and their application in automotive engineering.	8	17
2.	**Unit 2: Different Elements of Hydraulic System** • Pumps and Motors: Types of hydraulic pumps (gear, piston, vane) and motors, their characteristics and operation. • Cylinders: Selection criteria, types, and working of hydraulic cylinders. • Valves: Types of valves (directional, pressure, flow) and their operation. • Pipes, Tubing, and Fittings: Construction, working, and selection criteria for pipes, hoses, and fittings in a hydraulic system. • Maintenance of Hydraulic Systems: Common maintenance practices, troubleshooting, and diagnostics.	14	31
3.	**Unit 3: Pneumatic Systems in Automotive Vehicles** • Air Compressors: Types of compressors (reciprocating, rotary), working, and their application in automotive systems. • Air Motors: Construction and working of air motors in automotive applications. • Control Valves: Types of pneumatic valves, working, and control in pneumatic systems. • Actuators and Mountings: Types and working of pneumatic actuators. • Filters, Regulators, and Lubricators: Role and operation in pneumatic systems.	8	17
4.	**Unit 4: Hydro-Mechanical Servo Systems and Electro-Pneumatics** • Hydro-Mechanical Servo Systems: Principles and applications in automotive vehicles. • Electro-Pneumatic Systems: Understanding of PLCs, ladder	16	35

	diagrams, and their role in controlling pneumatic systems. • Servo and Proportional Valves: Working and application of these valves in hydraulic and pneumatic systems. • Automotive Applications: • Hydraulic Tipping Mechanism: Construction and working of tipping systems. • Power Steering: Operation and components of hydraulic power steering systems. • Hydro-Pneumatic Suspension: Working principle and applications in automotive systems. • Air Brake Systems: Components and working of air brakes in heavy vehicles. • Maintenance and Troubleshooting: Common faults in pneumatic systems and troubleshooting techniques.		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**25**	**25**	**20**	**10**	**5**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Majumdar, S.R., "Oil Hydraulic Systems: Principles and Maintenance", TataMcGraw-HillPublishing Company Ltd., New Delhi, Fourth Reprint, 2003.
2. Peter Rohner, "Fluid Power Logic Circuit Design – Analysis, Design Method and Worked Examples", The Macmillan Press Ltd., UK, 1979.
3. Festo KG, "Pneumatic Tips", Festo, Germany, 1987.
4. Andrew Parr, "Hydraulic and Pneumatic", Jaico publishing house, 1999.
5. Mc Clay Donaldson, "Control of fluid power analysis and design", Ellis HorwoodLtd.
6. Anthony Espisito, " Fluid Power with Application", Pearson Education Singapore)Pte.Ltd, Delhi, India, Fifth Edition, First Indian Reprint, 2003
7. Werner Deppert and Kurt Stoll, "Pneumatic Controls : An introduction to Principles", Vogel-Druck Wurzburg, Germany, 1975
8. Pippenger, J.J, "Industrial Hydraulic & Pneumatics", McGraw Hill, 2002.

9. Anderson B W "The analysis and design of pneumatic systems", John Wiley.
10. A. B. Goodwin, " Fluid Power Systems", McMillan Pub. Co.

(b) Open-source software and website:

OpenFOAM, Simulink (MATLAB), GEM(Gasoline Engine Management) Simulations, PyFOAM, CFDTool and FreeCAD etc.

Website: https://www.sae.org/
Website: https://www.researchgate.net/
Website: https://www.cfd-online.com/

Suggested Course Practical List: If any

1. Study the properties of hydraulic fluid
2. Demonstrate the construction and working of different types of pumps (gear, piston, vane)
3. Study the working of hydraulic cylinders and their selection criteria
4. Perform maintenance on a hydraulic system
5. Study the operation of pneumatic components: compressors, actuators, and valves
6. Troubleshoot pneumatic circuits
7. Implement a ladder diagram for controlling a pneumatic system using PLC
8. Study the working of an air brake system

Online Learning Platforms

- NPTEL Courses:, https://nptel.ac.in, etc.

Suggested Project List:

1. Design and development of a hydraulic braking system prototype.
2. Simulation of a hydro-pneumatic suspension system for improved ride comfort.
3. Development of a pneumatic lifting mechanism for automotive applications.
4. Study and optimization of an air brake system for heavy vehicles.
5. Design and testing of an electro-hydraulic servo steering system.
6. Troubleshooting and performance analysis of a hydraulic tipping mechanism.
7. Design and implementation of a pneumatic gear-shifting mechanism.
8. Simulation of a hydraulic power steering system using CAD/CAE tools.
9. Study of proportional and servo valves in automotive fluid power systems.
10. Development of a PLC-controlled electro-pneumatic control circuit for an automated vehicle function.

11. Performance evaluation of different hydraulic fluids under varying temperatures and pressures.
12. Design of a pneumatic actuation system for vehicle doors or hoods.
13. Analysis of energy efficiency in hydraulic systems for forklifts or other material-handling equipment.
14. Development of a compressed air energy storage system for pneumatic vehicles.
15. Study and design of a hydraulic clutch system for automotive applications.

Suggested Activities for Students:

1. Prepare a report on different types of hydraulic and pneumatic systems used in automotive applications.
2. Conduct a case study on the maintenance and troubleshooting of a hydraulic braking system.
3. Develop a ladder diagram for an electro-pneumatic control system using PLC.
4. Perform a comparative study on hydraulic fluids and their properties under varying conditions.
5. Create a flowchart to illustrate the working of a hydro-pneumatic suspension system.
6. Visit an automobile workshop to observe hydraulic power steering systems in operation.
7. Design and simulate a basic pneumatic control circuit for lifting mechanisms.
8. Analyze the energy losses in a hydraulic system using standard test equipment.
9. Create a presentation on the role of proportional and servo valves in fluid power systems.
10. Participate in a group discussion on the future trends in electro-hydraulic and electro-pneumatic systems.
11. Build a small-scale hydraulic jack model for demonstration purposes.
12. Conduct a failure analysis of a pneumatic braking system based on real-world data.
13. Research and present on hydraulic tipping mechanisms in dump trucks.
14. Design a hydraulic circuit diagram for a given automotive application.
15. Simulate the working of a hydraulic pump and motor using modeling software.

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