GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Mechanical Engineering and Allied Branches)
Subject Code: BE05000471
Subject Name: Oil Hydraulic and Pneumatics

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC

Prerequisite:	Nil
Rationale:	This course provides a comprehensive introduction to fluid power, including both oil hydraulics and pneumatics. The course gives an idea about the basic system working on fluid power and compressed air. Also, different valves related to hydraulic and pneumatic systems are discussed in the syllabus. The subject is also useful for designing the various hydraulic and pneumatic circuits for various engineering applications.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Explain the fundamentals of hydraulic and pneumatic systems, including their principles, components, symbols, electrical elements, advantages, limitations, and applications in engineering systems. OR Explain basic components, elements, symbols, and applications of electric, hydraulic, and pneumatic systems.	20
CO-2	Discuss various types of hydraulic oil, air filter, construction & working of the hydraulic pumps, hydraulic motors, control components in hydraulic systems, and actuators. OR Apply the principles of hydraulic oils, filtration systems, pumps, motors, valves, and actuators for the design, operation, and maintenance of hydraulic systems in engineering applications.	35
CO-3	Illustrate the function, construction & working of the various components of pneumatic systems.	20
CO-4	Design hydraulic, pneumatic, and actuator circuits for specific applications.	15
CO-5	Apply automation principles in hydraulic and pneumatic systems, including circuit design and simulation using relevant software tools.	10

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	00	00	15	60	02	70	30	00	30	00	130

Content:

Sr. No.	Content	Total Hrs
1	**Introduction To Hydraulics and Pneumatics Systems:** Introduction, Basic system of Hydraulics, Major advantages and disadvantages, Comparison among electrical, hydraulics, and pneumatics systems, History of development of fluid power, Principles of hydraulic fluid power, Hydraulic symbols, Electrical elements used in hydraulic circuits. Basic requirements for pneumatic systems, Basic symbols of pneumatic systems, Electrical elements used in pneumatic systems, Application of hydraulic and pneumatic systems.	**08**
2	**Hydraulic Oils and Filters:** Purpose of hydraulic oil, Types of hydraulic oil, Classification mineral based, Fire-resistant & biodegradable oils, Ideal characteristics of hydraulic oil, Maintenance of hydraulic oil, Filters, Types of filters, Material used for filter, Location of filter, Contaminations.	**06**
3	**Hydraulic Pumps, Motors, Valves, and Actuators:** **Hydraulic Pumps:** Classification of hydraulic pumps, Pump specifications. Construction & working of gear pump, vane pump, radial piston pump, axial pump, Maintenance & troubleshooting. **Hydraulic Motors:** Hydraulic motors, Constructional features, and performances of gear motor, vane motors, and piston motors. **Control Components in Hydraulic Systems:** Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Cartridge valves, Pressure intensifiers, Reservoirs, Accumulators. **Actuators:** Types of hydraulic actuators, Selection criterion of actuators, Linear and rotary Actuators.	**10**
4	**Pneumatics System:** **Air Preparation and Service Unit:** Types & selection criteria for air compressors, Air receiver, Pipeline layout, Air filter, Air dryer, Pressure regulator, and Lubricator (FRL unit). **Pneumatic Cylinders and Motors:** Types of pneumatic cylinders & air motors, Cushion assembly, Mounting arrangements, **Pneumatic Valves:** Pneumatic direction control valves, Quick exhaust, Time delay shuttle and Twin pressure valves.	**10**
5	**Circuit Design and Analysis:** Basic hydraulic circuits, Industrial hydraulic circuits, Power losses in flow control circuits, Basic pneumatic circuits, Development of single actuator circuits, Development of multiple actuator circuits, Cascade method for sequencing.	**6**
6	**Automation and Simulation of Hydraulics and Pneumatics:** Introduction to Automation in hydraulic and Pneumatic Systems, Case study of automation using hydraulics and pneumatics. Introduction to software of hydraulic and pneumatic systems, Circuit designing in software, Simulation in software, Simulation with actual components using software like automation in industry.	**5**
	Total	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**35**	**10**	**5**	**5**

R: Remembrance; U: Understanding; A: Application, N: Analyze, and E: Evaluate C: Create and above Levels (Revised Bloom's 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 the above table.

The syllabus of Oil Hydraulic and Pneumatic System directly contributes to

Chapter / Topic	SDG No.	Sustainable Development Goals
Chapter-1	**SDG-7** **SDG-9**	**Ensure access to affordable, reliable, sustainable and modern energy:** Application of hydraulic, electrical and pneumatic systems. **Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation:** by knowledge of efficient hydraulic, electrical and pneumatic systems in industrial automation and infrastructure.
Chapter-2	**SDG 12**	**Ensure sustainable consumption and production patterns:** Use of biodegradable and fire-resistant oils reduces environmental pollution.
Chapter-3 and Chapter-4	**SDG-7** **SDG-9**	**Ensure access to affordable, reliable, sustainable and modern energy:** Students able to find affordable, reliable, sustainable and modern components in hydraulic and pneumatic systems. **Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation:** by knowledge of efficient pumps, motors, cylinder valve and air preparation unit improve energy utilization.
Chapter-5	**SDG 12**	**Ensure sustainable consumption and production patterns:** Optimized circuit design minimizes energy losses and improves efficiency.
Chapter-6	**SDG 9**	**Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation:** Students able to sustainable industrialization and foster innovation by automation in hydraulic and pneumatic systems and optimize design in software.

Reference Books:

1. Hydraulic and Pneumatic Power and Control by Franklin D. Yeaple, McGraw Hill.
2. Industrial Hydraulics by John Pippenger and Tyler Hicks, McGraw-Hill.
3. Oil Hydraulic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
4. Hydraulic and Pneumatics, Andrew Parr, Elsevier (3rd Edition)
5. Fluid Power with Applications by Anthony Esposito, Pearson.
6. Fluid Power: Generation, Transmission and Control, Jagadeesha T., Thammaiah Gowda, Wiley.
7. The Analysis & Design of Pneumatic Systems by B. W. Anderson, John Wiley.
8. Hydraulic and Pneumatic Controls: Understanding made Easy, K.ShanmugaSundaram, S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)
9. Basic Pneumatic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
10. Electrohydraulic Servomechanisms by Allen C. Morse, McGraw-Hill, 1963.

List of Open-Source Software/learning website:

1. https://nptel.ac.in/courses/112105046
2. https://onlinecourses.nptel.ac.in/noc26_me51/preview
3. https://onlinecourses.nptel.ac.in/noc21_me51/preview
4. https://onlinecourses.nptel.ac.in/noc25_me38/preview
5. http://acl.digimat.in/nptel/courses/video/112106300/112106300.html
6. http://elearn.psgcas.ac.in/nptel/courses/video/112105047/112105047.html
7. Hopsan, Free & open-source simulation tool, used for fluid power systems (hydraulics & pneumatics).
8. Bosch Rexroth Scheme Editor, Free software for pneumatic and hydraulic circuit design.
9. HydraForce i-Design, Free tool for hydraulic circuit and manifold design
10. Elmer FEM Solver, Free multiphysics tool, Can simulate fluid flow, heat transfer, and hydraulic systems
11. Code_Saturne, Open-source CFD software, Used for fluid flow and hydraulic analysis

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration

4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment
7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3h per topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.

16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research laboratory visit	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for report writing 1h	Based on the proof of attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Oil Hydraulic and Pneumatics compulsorily incorporates Micro Project and 5 marks as PBL activities** These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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