



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Mechatronics Engineering

Course / Subject Code : DI03020021

Subject Name : Fundamentals of Thermal and Fluid Devices

w. e. f. Academic Year:	2024-25
Semester:	3 rd
Category of the Course:	PCC

Rationale:	Thermal energy, 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, automobiles and in equipment related with marine, mining, metal processing. The mechatronics engineer should be aware of concepts, principles, laws and applications of Thermal energy, hydraulic and pneumatic systems. This course has been introduced to develop necessary knowledge and skills in Thermal energy, hydraulic and pneumatic systems among diploma students of mechatronics.
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Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Analyse the thermodynamic processes of pure substance and steam formation process with P-V, T-S and H-S diagrams.	U
02	Analyse the applications of fluid mechanics for lubrication systems also.	U/A
03	Fundamentals of Fluid Properties & hydraulic devices working & Construction details	A / U
04	Fundamentals of Pneumatic devices working & Construction details	A/U

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE (V)	
03	00	00	03	70	30	0	0	100



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4. Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Fundamentals of Thermodynamics	10	24
2.	Fluid Mechanics and Lubrication Systems	12	28
3.	Hydraulic Devices	10	24
4.	Pneumatic Devices	10	24
	Total	42	100

5. Suggested Specification Table with Marks (Theory):

Sr.No	Unit Title	Teaching Hours	Distribution of Theory Marks (in %)						Total Marks
			R	U	A	N	E	C	
1.	Fundamentals of Thermodynamics	10	6	4	4	-	3	-	17
2.	Fluid Mechanics and Lubrication Systems	12	6	8	4	-	3	-	21
3.	Hydraulic Devices	10	2	5	5	2	-	2	16
4.	Pneumatic Devices	10	4	5	5	2	-	-	16
		42	18	22	18	04	06	02	70
			26%	30%	26%	6%	9%	3%	100%

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

6. COURSE DETAILS:-

Unit	Major Learning Outcomes(Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I. Fundamentals of Thermodynamics	1a. Explain forms of energy interaction (energy transfer) and the law of conservation of energy. 1b. Explain properties of thermodynamics systems and the Zeroth, First, Second laws of	1.1 Forms of energy and energy interaction, Steady flow energy equation. 1.2 Law of conservation of energy; concepts of heat, specific heat, work, process and cycles. 1.3 Simple Numerical based on Heat,



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	thermodynamics with sketches for two phase system. 1c. Explain the principle of heat reservoir, source-sink, refrigerator, heat engine and pump . 1d. Analyse the thermodynamic processes of pure substance and steam formation process with P-V, T-S and H-S diagrams .	Work, Process & Cycle. 1.4 Thermodynamic systems, properties; Zeroth law, First law, Second law of thermodynamics, two phase system. 1.5 Continuity of mass flow; heat reservoir, source-sink, heat engine, heat pump and refrigerator. 1.6 Different Thermodynamic processes and it's representation on P-V and T-S diagrams; P-V, T-S and H-S diagrams of pure substance. 1.7 Steam formation process on above diagrams.
Unit– II Fluid Mechanics and Lubrication Systems	2a. Explain types of fluid flow and their classifications 2b. Describe properties of hydraulic fluids. 2c. Explain Bernoulli's theorem governing fluid flow. 2d. Explain need of lubricants and selection criteria for it. 2e. Describe the types of lubricants and methods of lubrication.	2.1 Properties of fluid: Density- (Mass, Specific Weight, Relative Density), Viscosity In Gases And Liquid(Coefficient of Dynamic Viscosity, Kinematic Viscosity), Specific Gravity, Compressibility, Elasticity , Surface Tension, 2.2 Simple Numerical based on Properties of Fluids 2.3 Types of fluid flow; Bernoulli's theorem. 2.4 Lubrication: Need, Different types of lubricants, properties and applications. 2.5 Methods of lubrication and lubricating devices.
Unit–III Hydraulic Devices	3a. Explain the working principle of various pumps, control valves, actuators. 3b. Explain application of various valves: direction control, flow control, pressure control valves. 3c. Describe the working principle and application of hydraulic accumulators with sketches. 3d. Explain working principle and application of hydraulic devices: lift, ram, press, and intensifier with	3.1 Sketch, constructional features, (constructional and flow diagram with symbols), working and applications of following devices: Various types of pumps: rotary centrifugal, gear, reciprocating, Various control valves 3.2 Pelton, Kaplan and Francis turbines 3.3 Hydraulic Actuators: Hydraulic lift 3.4 Hydraulic ram, Accumulator, Hydraulic press.



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	sketches.	
Unit-IV Pneumatic Devices	4a. 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 Pressure control elements 4b. Describe working of Pneumatic valves: direction control, flow control, pressure control valves. 4c. Describe linear actuator and rotary actuators.	4.1 Sketch (constructional and flow diagram with symbols), constructional features, working and applications of following devices: Air compressor 4.2 Flow control valves : seawater ball valve, Butterfly valve , gate valve(rising and non-rising-stem), globe valve , Stop Valve, Three-Way Valve 4.3 Directions control valves 4.4 Pressure control elements

NOTES:-

- I. More Practical Exercises can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list.
- II. It is compulsory to prepare log book/continuous records of exercises. It is also required to get each exercise recorded in log book/continuous records, checked and duly dated signed by teacher. CA component of practical marks is dependent on continuous and timely evaluation of exercises.
- III. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
 - a. Brief details of industry visited.
 - b. Type, location, products, rough layout, human resource, etc., of industry.
 - c. Details, description and broad specifications of machineries/processes observed.
 - d. Safety norms and precautions observed.
 - e. Any other details/ observations asked by accompanying faculty.
- IV. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned the necessary data and should be given any one experience to perform. The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the



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course) that occur in the above-listed Practical Exercises of this course required, which are embedded in the COs and, ultimately, the competency.

8. References/Suggested Learning Resources:

A. Books:

Sr. No.	Title of Book	Author	Publication
1.	Fundamentals Of Fluid Mechanics	Kumar, D.S.	S.K.Kataria and Sons, New Delhi
2.	Fluid Mechanics and Hydraulic Machines	Khurmi, R.S.	S.Chand Publications, New Delhi
3.	Thermodynamics For Engineers	Mathur, M.L.	Metropolitan Book Company
4.	Thermodynamics	Khurmi, R.S.	S.Chand Publications, New Delhi
5.	Oil Hydraulic Systems	Majumdar, S.R.	Tata Mcgraw-Hill Publication, New Delhi
6.	Pneumatic Systems	Majumdar, S.R.	Tata Mcgraw-Hill Publication, New Delhi
7.	Hydraulic And Pneumatic Controls	Srinivasan, R.	Vijay Nicole Imprints Private Limited

B. List of Major Equipment/ Instrument with Broad Specifications

1	Centrifugal pump	01
2	Reciprocating pump	01
3	Pelton turbine test rig	01
4	Francis turbine test rig	01
5	Air compressor test rig	01
	Bernoulli's apparatus.	
6	Reynolds's apparatus	01
7	Hydraulic Trainer Kit	01
8	Electro-Hydraulic Trainer Kit	01
9	Pneumatic trainer kit	01



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C. List of Software/Learning Websites

- i. www.boschrexroth.co.in
- ii. <http://www.howstuffworks.com/search.php?terms=hydraulics>
- iii. <http://hyperphysics.phy-astr.gsu.edu/hbase/fluid.html#flucon>
- iv. <http://hyperphysics.phy-astr.gsu.edu/hbase/heacon.html#heacon>
- v. <http://www.brighthubengineering.com/fluid-mechanics-hydraulics/>
- vi. <http://www.brighthubengineering.com/thermodynamics/>
- vii. <http://www.genchem.net/thermo/laws.html>
- viii. <http://www.nfpa.com/default.aspx>
- ix. <http://www.automationstudio.com/>
- x. www.boschrexroth.co.in
- xi. www.festo.com
- xii. www.nptel.iitm.ac.in
- xiii. Automation Studio 5.0 or higher version

D. References:

- 1] Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
- [2] Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education
- [3] Hanes et al "IoT Fundamentals", Cisco Press
- [4] Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", Paperback, 2015.
- [5] A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
- [6] Yashwant Kanetkar, "21 Internet of Things Experiments", Kindle edition
- [7] Adeel Javed, "Building Arduino projects for Internet of Things", Apress publication
- [8] Donald Noris, "The Internet of Things: Do it yourself Projects with Arduino, Raspberry PI and BeagleBone Black" Mc Graw Hill Publication
- [9] Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication
- [1] Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
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10. Suggested Project List & Student Activities:

Following is the list of proposed student activities such as:

- i. Prepare journals based on practical performed in laboratory.
- ii. Assignments on solving numerical.
- iii. 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.
- iv. Download the catalogue of Hydraulic devices.
- v. Download the catalogue of Pneumatic devices.
