GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: FUNDAMENTALS OF THERMAL AND FLUID DEVICES
(COURSE CODE: 3352001)

Diploma Programme in which this course is offered	Semester in which offered
Mechatronics Engineering	5th Semester

1. 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.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Apply the principles of thermal energy, hydraulic and pneumatic systems in automation work of machines.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

i. Analyse the thermodynamic processes of pure substance and steam formation process with P-V, T-S and H-S diagrams
ii. Apply thermodynamic cycles with P-V, T-S and H-S diagrams
iii. Analyse the applications of fluid mechanics for lubrication systems also.
iv. Maintain hydraulic devices
v. Maintain pneumatic devices

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total
L	T	P	C	ESE	PA	ESE	PA	
4	0	2	6	70	30	20	30	150

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

5. COURSE CONTENT DETAIL

Unit	Major Learning Outcomes (in cognitive domain)	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 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 .	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 Thermodynamic systems, properties; Zeroth law, First law, Second law of thermodynamics, two phase system. 1.4 Continuity of mass flow; heat reservoir, source-sink, heat engine, heat pump and refrigerator. 1.5 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. 1.6 Steam formation process on above diagrams.
Unit– II Thermodynamic Cycles and Heat Transfer	2a. Compare Close loop and open loop system 2b. Explain thermodynamics cycles with P-V and T-S diagrams. 2c. Describe application of different thermodynamic cycles and the relations of variables of the thermodynamics cycles with simple numerical examples 2d. Differentiate between reversibility and irreversibility	2.1 Thermodynamic cycle; Close loop and open loop system. 2.2 Reversibility and irreversibility 2.3 Thermodynamics cycles with P-V and T-S diagram and related expression (no derivation) • Carnot cycle • Otto cycle • Diesel cycle • Brayton cycle • Rankine cycle
	2e. Describe modes of heat transfer. 2f. Explain conduction of heat transfer. 2g. Explain convection of heat transfer. 2h. Explain radiation of heat transfer 2i. Describe heat exchanger	2.4 Various mode of heat transfer. 2.5 Conduction heat transfer, Fourier's law, thermal conductivity and heat transfer through composite wall and cylinders. 2.6 Convection heat transfer, Newton's law of convection, Free and force convection, Coefficient of convection.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		2.7 Radiation heat transfer, Stefan and Boltzmann's law, Black body concept. 2.8 Heat exchanger: types and applications.
Unit– III Fluid Mechanics and Lubrication Systems	3a. Explain types of fluid flow and their classifications 3b. Describe properties of hydraulic fluids. 3c. Explain Bernoulli's theorem governing fluid flow.	3.1 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, 3.2 Types of fluid flow; Bernoulli's theorem.
	3a. Explain need of lubricants and selection criteria for it. 3b. Describe the types of lubricants and methods of lubrication.	3.3 Lubrication : Need , Different types of lubricants, properties and applications. 3.4 Methods of lubrication and lubricating devices.
Unit–IV Hydraulic Devices	4a. Explain the working principle of various pumps, control valves, actuators. 4b. Explain application of various valves: direction control, flow control, pressure control valves. 4c. Describe the working principle and application of hydraulic accumulators with sketches. 4d. Explain working principle and application of hydraulic devices: lift, ram, press, and intensifier with sketches.	4.1 Sketch, constructional features, (constructional and flow diagram with symbols), working and applications of following devices: • Various types of pumps: rotary centrifugal, gear, reciprocating, • Pelton, Kaplan and Francis turbines • Various control valves • Hydraulic Actuators: Hydraulic lift • Hydraulic ram, Accumulator, Hydraulic press, Manifold, Intensifier
Unit-V Pneumatic Devices	5a. 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	5.1 Sketch (constructional and flow diagram with symbols), constructional features, working and applications of following devices: • Air compressor • Flow control valves : seawater ball valve, Butterfly valve , gate valve(rising and non rising-stem), globe valve , Stop Valve, Three-Way Valve,

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	• Air motor • Air cylinder • Types of signal/switching devices : Pneumatic Proximity Switch (Air Catch Sensor), Pneumatic Valve Actuators - Limit Switch,-Vacuum , Foot , Flow, Pressure Switch 5b. Describe working of Pneumatic valves: direction control, flow control, pressure control valves. 5c. Describe linear actuator and rotary actuators. 5d. Describe various types of signal devices Describe various logical pneumatic circuits (operating of double acting cylinder, quick return mechanism, press machine)	• Directions control valves • Pressure control elements • Air motor • Air cylinder • Types of signal/switching devices : Pneumatic Proximity Switch (Air Catch Sensor), Pneumatic Valve Actuators - Limit Switch,-Vacuum , Foot , Flow, Pressure Switch 5.2 Logic pneumatic circuits (including operating of double acting cylinder, quick return mechanism, press machine)

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Thermodynamics	10	6	3	3	12
II	Thermodynamic Cycles and Heat Transfer	13	6	6	4	16
III	Fluid Mechanics Fundamentals and Lubrication Systems	08	3	5	4	12
IV	Hydraulic Devices	12	2	5	7	14
V	Pneumatic Devices	13	4	5	7	16
	Total	**56**	**21**	**24**	**25**	**70**

Legends: R = Remember U = Understand; A = Apply and above levels (Bloom's Revised 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 above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes***

(as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	**Practical Exercises** (outcomes in Psychomotor Domain**)**	Approx Hours. required
1	II	Demonstrate concentric heat exchanger.	2
2	II	Demonstrate measuring emissivity.	2
3	II	Demonstrate counter flow / Parallel flow heat exchanger.	2
4	III	Use Bernoulli's theorem.	2
5	III	Determine Reynolds's number.	2
6	III	Test Performance of centrifugal pump.	2
7	III	Determine the performance characteristics of Pelton wheel turbine under constant head and constant speed.	4
8	V	test Performance of air compressor.	2
9	IV	Identify the components of hydraulic systems	2
10	IV	Design hydraulic circuit for given problem using trainer kit	2
11	IV	Build the hydraulic circuit for the given application	2
12	V	Identify the components of pneumatic systems	2
13	V	Control double-acting cylinder, and knowing various types of speed regulation of the piston rod movement of double-acting cylinder.	2
14	V	Operate the pneumatic circuit for given problem using trainer kit	2
15	V	Demonstrate various types of speed regulation (throttling) of the piston rod movements of double-acting cylinders with one-way flow control valves are looked at and the effects are observed.	2
16	V	Build the pneumatic circuit for the given application	2
17	V	Identify the elements of an oil hydraulic system	2
Total Hours (perform any practical from above for 28 hours so that most units are covered.)			**38**

8. SUGGESTED LIST OF 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.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Arrange visit to nearby Hydraulic Power Station.
ii. Show video/animation films to explain functioning of induction valves/pumps/turbines and their accessories.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S. 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

	Name of the equipment	Quantity
i.	Centrifugal pump	01
ii.	Reciprocating pump	01
iii.	Pelton turbine test rig	01
iv.	Francis turbine test rig	01
v.	Air compressor test rig	01
vi.	Bernoulli"s apparatus.	01
vii.	Reynolds"s apparatus.	01
viii.	Hydraulic Trainer Kit	01
ix.	Electro-Hydraulic Trainer Kit	01
x.	Pneumatic trainer kit	01

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

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. P. S. Patel**, Lecturer in Mechatronics Engineering, B.S.Patel Polytechnic Kherva, Ganpat Vidhyanagar.
- **Prof. K. P. Patel**, Lecturer in Mechanical Engineering, B.S.Patel Polytechnic Kherva, Ganpat Vidhyanagar.
- **Prof. V. G. Patel**, Lecturer in Mechanical Engineering, B.S.Patel Polytechnic Kherva, Ganpat Vidhyanagar.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr Vandana Somkuwar**, Associate Professor, Department of Mechanical Engineering
- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering