

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: HYDRAULIC SYSTEMS
(COURSE CODE: 3361908)**

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	Sixth

1. RATIONALE.

The laws, principles and concepts of hydraulics play very important role in the innovation, development and improvement of engineering processes and devices. Different types of hydraulic elements like pumps, valves and actuators are essential elements in all the manufacturing industries. This course is designed to develop understanding of hydraulic systems which are widely used for operation and controls in machine tools, material handling, automobile, marine, mining, metal processing, equipment and other fields. This course also enables the diploma students to operate and troubleshoot different types of hydraulic systems in industries.

2. COMPETENCY.

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

- **Use and maintain hydraulic machineries based on fluid laws and characteristics.**

3. COURSE OUTCOMES.

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

- Select hydraulic fluid based on given conditions.
- Select, operate and maintain various hydraulic elements such as pumps and actuators.
- Operate and maintain various hydraulic control valves and accessories.
- Design hydraulic circuits by selecting suitable components for a given application.
- Operate and maintain various hydraulic devices such as hydraulic brake, power steering, jack etc.
- Install, maintain, and troubleshoot various hydraulic systems.

4. TEACHING AND EXAMINATION SCHEME.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

5. COURSE CONTENT DETAILS.

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
Unit – I Fundamentals of Hydraulics.	1a. Compare fluid power transmission with electrical and mechanical transmission. 1b. Describe various laws governing fluid flow. 1c. Select appropriate hydraulic fluid for given application.	1.1 Power transmission modes and comparison. 1.2 Fluid power – history, concept and definition. 1.3 Application of hydraulic and pneumatic in fluid power. 1.4 Hydrostatic and hydrodynamic-concept and definitions. 1.5 Definition and interrelationships of various terms (properties) used in hydraulics. 1.6 Laws governing fluid flow: i. Pascal’s law. ii. Continuity equation. iii. Bernoulli’s theorem. 1.7 Flow through pipes-types, pressure drop in pipes. 1.8 Hydraulic fluid - types, ISO/BIS standards and designations, properties and their advantages and limitations. 1.9 Hydraulic systems –applications, advantages and limitations.
Unit– II Hydraulic Elements-I.	2a. Select appropriate hydraulic pipe for given application. 2b. Describe pumping theory. 2c. Select and maintain appropriate pump for given application. 2d. Select and maintain appropriate hydraulic elements (actuators, motors and cylinders). 2e. Apply linear motion methods for cylinders in machineries.	2.1 Basic hydraulic system. 2.2 Hydraulic pipes – Types, standards, designation and specifications, pressure ratings, applications, selection criteria. 2.3 Pumping theory & classification. 2.4 General assembly sketch, main parts, working principle, working, applications and comparison of following pumps: i. External, Internal gear pumps & Ge-rotor.(Generator rotor). ii. Lobe. iii. Screw. iv. Vane. v. Piston. 2.5 Selection criteria of pumps. 2.6 Hydraulic Actuators - classification, construction, working and applications. 2.7 Cylinder cushions and mountings.

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
		2.8 Various methods of applying linear motion (horizontal, vertical, inclined, first class lever, second class lever, third class lever, bent lever, toggle lever mechanism).
Unit- III Hydraulic Elements-II.	3a. Use various hydraulic control valves. 3b. Differentiate between proportional and servo valve. 3c. Select and use various hydraulic accessories with its location on hydraulic system.	3.1 Classification of Hydraulic control valves. 3.2 Types, construction, working and applications of: i. Pressure control valves. ii. Directional control valves. iii. Flow control valves. iv. Proportional control valve (Proportional pressure relief valve, Proportional pressure reducing valve, Proportional direction valve). v. Servo control valves. (Mechanical hydraulic servo valve, Electro hydraulic servo valve, Single stage, two stage Flapper type, Jet pipe type). 3.3 Comparison of proportional and servo control valves. 3.4 Selection of control valves. 3.5 Hydraulic Accessories: types, construction, working and applications of: i. Strainers and filters. ii. Seals (static and dynamic). iii. Hydraulic reservoirs. iv. Hydraulic accumulators. v. Manifold. vi. Heat exchangers. vii. Oil level and pressure indicator.
Unit-IV Hydraulic Circuit Design.	4a. Describe ISO symbols and guiding rules for designing hydraulic system. 4b. Design hydraulic circuit based on given system requirements.	4.1 ISO symbols used in hydraulic circuits. 4.2 Circuit diagram, components, working and application of following hydraulic circuits: i. Control of single acting cylinder. ii. Control of double acting cylinder. iii. Pump unloading circuit.

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
		iv. Intensifier Circuit. v. Regenerative Circuit. vi. Synchronizing circuits. vii. Automatic Cylinder Reciprocation circuit. viii. Sequencing circuits. ix. Meter-in and Meter-out circuit. x. Two hand safety control. xi. Emergency cut-off control. 4.3 Hydraulic system design i. Method and steps of designing a hydraulic circuit from working conditions.
Unit-V Hydraulic Devices.	5a. Identify different parts in a given hydraulic device. 5b. Describe function and working of various parts in hydraulic devices.	5.1 Hydraulic Devices – Concept and applications. 5.2 Construction, working principle, major elements, performance variables and applications of following devices: i. Automotive hydraulic brake. ii. Industrial Fork lift. iii. Hydraulic jack. iv. Hydraulic press. v. Automotive power steering. vi. Hydraulic lift.
Unit-VI Installation, Maintenance and Trouble-Shooting.	6a. Describe steps for installation of various hydraulic components. 6b. Identify the various faults in the system and the remedial actions for them.	6.1 Installation of hydraulic system. 6.2 Causes and remedies for troubles arising in hydraulic elements. 6.3 Maintenance of hydraulic systems. i. Maintenance schedule. 6.4 Troubleshooting of hydraulic system.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (Theory):

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Hydraulics.	4	4	2	2	8
II	Hydraulic Elements-I.	8	4	4	4	12
III	Hydraulic Elements-II.	8	4	4	4	12
IV	Hydraulic Circuit Design.	12	4	8	6	18
V	Hydraulic Devices.	6	2	4	6	12
VI	Installation, Maintenance and Troubleshooting.	4	2	2	4	8
	Total	42	20	24	26	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.
- If mid-sem test is part of continuous evaluation, unit numbers I, II and III are to be considered.
- Ask the questions from each topic as per marks weight age. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The tutorial/practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills (**Outcomes in cognitive, psychomotor and affective domain**) so that students are able to acquire the competencies. 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.

Sr. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours. required
1	I	Preparatory activity: a. Tabulate properties of fluid, units and importance in fluid systems. b. Tabulate different hydraulic oil available in	02

Sr. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours. required
		market, ISO / BIS designation, important properties and applications.	
2	II,III	Demonstration of various hydraulic elements: <ol style="list-style-type: none"> Demonstrate various hydraulic elements covered in theory classes.. Tabulate all hydraulic elements with name, symbol, sketch, specifications and applications. Design the hydraulic system circuit based on given input and parameters and using simulation software. 	06
3	IV	Performance: <ol style="list-style-type: none"> Design, assemble and operate hydraulic system, based on given simple system requirements (Design mainly include selection and arrangement of elements). <ol style="list-style-type: none"> Control of single acting cylinder Control of double acting cylinder Meter-in and meter-out circuits Regenerative Circuit Synchronizing circuits Automatic Cylinder Reciprocation circuit Sequencing circuits (manual & automatic) Circuit using accumulator. Sketch the system diagram with symbols. Prepare the list of items and also list the steps of assembly. Observe and record the parameters. Change any one parameter and observe the effect on other parameters. 	16
4		Seminar presentation: <ol style="list-style-type: none"> Prepare and present seminar topic individually. (Seminar topic has to be given by teacher). Download visual aids, videos, contents and other related instructional material for the given case / situation. (Case/situation has to be given by teacher) Present and discuss the same in your class. 	4
Total Hours			28

Notes:

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher. PA component of practical marks is dependent on continuous and timely evaluation and submission of exercises.
- b. Term work report must not include any photocopy /ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- c. Each student will make his/her folder having the name as <batch number Enrollment number> and will save his/her presentation and downloaded content. A DVD is to be made which will contain folders of all students. Same DVD is to be submitted.
- d. Seminar presentation topic/area has to be assigned to the group of specified students in the beginning of the term by batch teacher.
- e. For practical ESE part, students are to be assessed for competencies achieved. They should be given to perform any one pneumatic system from experiment number 3.

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 theories taught in classroom.
- iii. Prepare/Download a dynamic animation to illustrate the following:
 - Working principle of hydraulic pumps.
 - Working principle of hydraulic valves and actuators.
 - Working of different types of hydraulic devices (applications).
- iv. Download the catalogue of Hydraulic devices.
- v. Arrange visit to nearby Hydraulic equipment based industries.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr.No.	Unit	Unit Name	Strategies
1	I	Fundamentals of hydraulics.	Demonstration of hydraulic devices, showing applications, videos.
2	II	Hydraulic elements-I.	Demonstration of elements working, dismantling of elements, presentations, actual uses, movies.
3	III	Hydraulic elements-II.	Demonstration of elements working, dismantling of elements, presentations, actual uses, movies.
4	IV	Hydraulic Circuit Design.	Demonstration of actual circuits, videos on steps to prepare circuit, on-hand practice, movies.
5	V	Hydraulic Devices.	Demonstration of hydraulic devices, showing applications, videos.
6	VI	Installation, Maintenance and Troubleshooting.	Demonstration of hydraulic devices in dismantled condition, exercise on identifying elements and faults, on-hand practice to maintain/repair simple devices, showing applications and videos.

10. SUGGESTED LEARNING RESOURCES**A) List of Books**

Sr. No.	Title of Book	Author	Publication
i.	Oil Hydraulic Systems	Majumdar, S.R.	Tata Mcgraw-Hill Publication, 3/e, 2013
ii.	Hydraulic and Pneumatic Controls	Srinivasan, R.	Vijay Nicole Imprints Private Limited, 2/e, 2008
iii.	Fluid Power Generation, Transmission and Control	Jagadeesha, T.	Universities Press (India) Private Limited, 1/e, 2014
iv.	Hydraulic And Pneumatics A Technician's & Engineer's Guide	Parr, Andrew	Jaico Publishing House, 2/e, 2013
v.	Hydraulic And Pneumatics Controls Understanding Made Easy	Shanmuga Sundaram, K.	S. Chand Company Ltd., 1/e, 2006
vi.	Industrial Fluid Power Vol. I, II, & III	Hedges, Charles S.	Womack Educational Publications, 3/e, 2009

B) List of Major Equipment/ Instrument with Broad Specifications

Sr. No.	Resource with brief specification.
i.	Electro-hydraulic Trainer kit (with/without proportional valves) Components required: Pump, Reservoir, pressure relief valve, check valves, Directional control valves (manual and electrically operated), Flow control valves (fixed and variable), pressure reducing valve, Cylinders, Motor, Accumulator, hosepipes, accessories and setup for electro-hydraulic circuits.
ii.	Working model of pumps, valves and actuators.
iii.	Cut section of various pumps, valves and actuators

C) List of Software/Learning Websites

- i. www.boschrexroth.co.in
- ii. <http://www.automationstudio.com/>
- iii. <http://www.howstuffworks.com/search.php?terms=hydraulics>
- iv. <http://hyperphysics.phy-astr.gsu.edu/hbase/fluid.html#flucon>
- v. <http://www.youtube.com/watch?v=FVR7AC8ExIM>
- vi. <http://www.youtube.com/watch?v=iOXRoYHdCV0>
- vii. <http://www.youtube.com/watch?v=qDinpuq4T0U>
- viii. <http://www.youtube.com/watch?v=xxoAm3X4iw0>

- ix. <http://www.youtube.com/watch?v=JsFcfudj3rE>
- x. <http://www.youtube.com/watch?v=CoprDVMvKso>
- xi. <http://www.youtube.com/watch?v=YxxSmz86zDg>
- xii. <http://www.brighthubengineering.com/fluid-mechanics-hydraulics/>
- xiii. <http://www.hypneu.com/index.html>
- xiv. <http://www.nfpa.com/default.aspx>
- xv. www.festo.com
- xvi. www.nptel.iitm.ac.in
- xvii. Automation Studio 5.0 or higher version
- xviii. Festo Fluidsim,
- xix. Hypneu, AUTOMSIM, LVSIM®HYD, LogicLab, etc.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE.

Faculty Members from Polytechnics.

- **Prof. P. S. Patel**, Lecturer in Mechatronics Engineering, B. S. Patel Polytechnic, Ganpat vidhyanagar, Kherva.
- **Prof. M. A. Patel**, Lecturer in Mechatronics Engineering, B. S. Patel Polytechnic, Ganpat vidhyanagar, Kherva.
- **Prof. H. M. Shah**, Lecturer in Mechanical Engineering, B. S. Patel Polytechnic, Ganpat vidhyanagar, Kherva.
- **Prof. H. R. Saprumer**, Lecturer in Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.

Coordinator and Faculty Members from NITTTR, Bhopal.

- **Dr. K. K. Jain**, Professor, Department. of Mechanical Engineering,
- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering,

SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			II
	iv.		2			II
	v.		2			III
	vi.		2			III
	vii.		2			IV
	viii.		2			IV
	ix.			2		I
	x.		2			V
2	a.				3	I
		OR				
	a.				3	I
	b.			3		II
		OR				
	b.			3		II
	c.			4		III
		OR				
	c.			4		III
	d.				4	IV
		OR				
	d.				4	IV
3	a.				3	VI
		OR				
	a.				3	VI
	b.				3	III
		OR				
	b.				3	III
	c.	MINOR CIRCUIT		4		IV
		OR				
	c.	MINOR CIRCUIT		4		IV
	d.			4		V
		OR				
	d.			4		V
4	a.			3		VI
	a.			3		VI
	b.				4	II
		OR				
	b.				4	II
	c.	MAJOR CIRCUIT		7		IV

5	a.				4	V
	b.	SYMBOLS	4			IV
	c.			3		III
	d.				3	V