

**COURSE TITLE** : **FLUID MECHANICS AND PNEUMATICS**  
**COURSE CODE** : **3037**  
**COURSE CATEGORY** : **B**  
**PERIODS/WEEK** : **5**  
**PERIODS/SEMESTER** : **90**  
**CREDITS** : **5**

**TIME SCHEDULE**

<b>MODULE</b>	<b>TOPICS</b>	<b>PERIODS</b>
1	Introduction Properties of Fluids Fluid pressure and its measurements	21
2	Kinematics and Dynamics of Fluid flow Flow through Orifices, Notches, Pipes and Nozzles	22
	TEST I	2
3	Fluid Power Hydraulic system Hydraulic Control elements and components Hydraulic Circuits	22
4	Pneumatic System Pneumatic Control elements and Components Pneumatic Circuits Hydro Pneumatic system	21
	TEST II	2
	<b>Total</b>	<b>90</b>

**OBJECTIVES**

Upon completion of the study of this subject, the student should be able to:

**MODULE– I**

**1.1.0 Understand the importance of Hydraulics**

1.1.1 Explain the areas of application of Hydraulics

**1.2.0 Appreciate the properties of Hydraulic Fluids**

1.2.1 Explain the various properties of commonly used hydraulic fluids

1.2.2 Solve the problems related to density, specific weight, specific volume, and specific gravity.

**1.3.0 Understand Fluid Pressure and the methods to Measure it**

1.3.1 Explain the terms pressure and pressure head and solve problems on these

1.3.2 State and explain Pascal's law

1.3.3 Explain Absolute, Gauge, Atmospheric and Vacuum pressures and Solve simple problems on those.

1.3.4 State the fundamental principles of pressure measuring devices balancing by liquid columns

1.3.5 Explain and illustrate the principle of working of piezometer, simple U-tube manometer, differential manometer, inverted differential manometer bourdon's tube pressure gauge and solve simple problems on those.

1.3.6 Explain the term total pressure

1.3.7 Solve problems using equations of total pressure on an immersed surface in positions of horizontal, vertical and inclined

**MODULE– II**

**2.1.0 Understand the Principles Kinematics and Dynamics of Fluid Flow**

2.1.1 Explain the term Kinematics

- 2.1.2 Explain the types of fluid flow – steady and unsteady flow, uniform and non-uniform flow, Laminar and Turbulent flow, compressible and incompressible flow – rotational and Irrotational flow, one dimensional flow, two dimensional flow, and three dimensional flow
- 2.1.3 Explain Rate of Discharge
- 2.1.4 Explain the equation for continuity of flow
- 2.1.5 Solve simple problems on 2.1.3 and 2.1.4
- 2.1.6 Explain the energies possessed by a liquid particle that is potential, kinetic and pressure
- 2.1.7 Define total energy and total head
- 2.1.8 State Bernoulli's equation(No Derivation)
- 2.1.9 State the limitations of the Bernoulli's theorem
- 2.1.10 Solve problems using Bernoulli's equation
- 2.1.11 Explain practical applications of Bernoulli's equation, Venturimeter and solve problems using it.
- 2.1.12 Sketch a pitot tube and explain how it is used to measure the velocity of a flowing liquid

## **2.2.0 Appreciate the Flow of Liquids through Orifices Notches and Pipes**

- 2.2.1 Explain the Orifices, types of Orifices, point of vena-contracta and Hydraulic coefficient  $C_c$ ,  $C_v$  and  $C_d$
- 2.2.2 Solve simple problems of hydraulic coefficients
- 2.2.3 Explain Notches, types of Notches
- 2.2.4 Know the equation for discharge over rectangular Notches, Triangular Notches and Trapezoidal Notches.
- 2.2.5 Mention the advantages of Triangular Notch over a Rectangular Notch
- 2.2.6 Define coefficient of discharge of a Notch
- 2.2.7 Solve simple problems on 2.2.4
- 2.2.8 Explain losses of head in pipes and identify Major losses and Minor losses
- 2.2.9 Explain the significance of losses of head due to friction in pipe flow
- 2.2.10 Understand Darcy's formula and Chezy's formula for loss of head in pipes and explain the terms hydraulic mean depth and hydraulic gradient
- 2.2.11 Solve the problems on 2.2.10
- 2.2.12 Understand the equation of loss of head due to sudden enlargements and loss of head due to sudden contraction loss of head at the entrance in a pipe and loss of head at the exit of a pipe
- 2.2.13 Solve the problems on 2.2.12
- 2.2.14 Understand the transmission of power through pipes and the equation for power transmitted through a pipe
- 2.2.15 Solve simple problems on 2.2.14
- 2.2.16 Explain water hammer

## **MODULE – III**

### **3.1.0 Understand the Fluid Power Technology**

- 3.1.1 Understand the basic law
- 3.1.2 Identify the applications of fluid power
- 3.1.3 Know the essential properties of the fluids such as viscosity index, Oxidation stability, Demulsibility, Lubricity, Rust prevention, Pour point, Flash and fire point, Neutralisation number.

### **3.2.0 Identify the elements of Hydraulic System**

- 3.2.1 Classify the pumps
- 3.2.2 Identify Positive displacement pumps
- 3.2.3 Explain the working principle of Positive displacement pumps
- 3.2.4 Describe gear pumps, vane pumps, piston pumps
- 3.2.5 Explain the Type of Hydraulic Actuators – Rotary (Hydraulic motor) – Semi-rotary- linear motion type (Hydraulic cylinders)

### **3.3.0 Understand the various control elements of various hydraulic control System**

- 3.3.1 Describe the working principle of different control valves – pressure control valves, direction control valves and flow control valves.

- 3.3.2 Know the applications of valves
- 3.3.3 Describe the types of accumulator
- 3.3.4 List the purpose of accumulators

### **3.4.0 Know the hydraulic circuits**

- 3.4.1 Describe Automatic cylinder reciprocating circuit
- 3.4.2 Describe hydraulic circuit for robotic arm

## **MODULE – IV**

### **4.1.0 Understand the basic concept of pneumatic system**

- 4.1.1 Compare Pneumatic system with hydraulic system
- 4.1.2 Identify standard pneumatic symbols
- 4.1.3 Know the basic component of pneumatic system – air filters, pressure regulator – lubricator – mufflers
- 4.2.0 Understand pneumatic control elements and components
  - 4.2.1 Explain with sketches pneumatic valves – direction control valves- pressure control valve and flow control valves
  - 4.2.2 Describe the pneumatic actuators – pneumatic cylinders, air motors – types applications
- 4.3.0 Understand the simple pneumatic circuit
  - 4.3.1 Describe the principle of power operated holding devices, chuck, mandrel, collet clamping circuits

### **4.4.0 Understand the working of Hydro pneumatic system**

- 4.4.1 Compare hydraulic pneumatic and hydro pneumatic systems
- 4.4.2 State the advantage and application system of air and oil
- 4.4.3 Explain the principle of working of air controlled valves and oil controlled valves
- 4.4.4 Sketch the arrangements for the control of hydraulic circuits by air
- 4.4.5 Explain the use of air that acts as cushion in hydraulic system

## **CONTENT DETAILS**

### **MODULE – I**

#### **Introduction**

Importance of Hydraulics

#### **Properties of Fluids**

Density – specific weight – specific volume – specific gravity – problems – viscosity – kinematics viscosity – Newton’s law of viscosity – types of fluids – compressibility – surface tension – capillarity

#### **Fluid pressure and its measurement**

Fluid pressure at a point – pressure head – problems – Pascal’s law – absolute, gauge, atmospheric and vacuum pressures – simple problems – measurement of fluid pressure – Piezometer tube – simple manometer – differential manometer – inverted differential manometer – Bourdon’s tube pressure gauge – problems – total pressure – total pressure on immersed surface – horizontal – vertical – inclined – problems.

### **MODULE – II**

#### **1. Kinematics and Dynamics of fluid flow**

Introduction – types of fluid flow – steady and unsteady flow – uniform and non-uniform flow – laminar and turbulent flow – compressible and incompressible flow – rotational and ir-rotational flow – one, two and three dimensional flow – rate of flow or discharge – equation of continuity of a liquid flow – simple problems – energy of a liquid in motion – potential energy – kinetic energy – pressure energy – total energy – total head of liquid in motion – Bernoulli’s equation(No derivation ) – assumptions – simple problems – practical applications of Bernoulli’s equation – venturimeter – Orifice meter – Pitot tube – simple problems.

#### **2. Flow through Orifices, Notches, Pipes and Nozzles**

Orifices – types of orifices – Vena contracta – coefficient of contraction – coefficient of velocity – coefficient of discharge – problems

Notches – types of notches – Rectangular notches – triangular notch – trapezoidal notch – discharge over notches – simple problems

Simple pipes – loss of head in pipes – major energy losses – minor energy losses – loss of energy due to friction – Darcy's formulae (No derivation) for loss of head in pipes – Chezy's formula (No derivation) for loss of head in pipes – simple problems – loss of head due to sudden enlargement – loss of head due to sudden contraction (No derivation) – problems transmission of power through pipes – problems – water hammer .

### **MODULE – III**

#### **1.Fluid Power**

Introduction – Basic law – Applications of fluid power – properties of fluids such as viscosity index Oxidation stability, Demulsibility, Lubricity, Rust prevention, Pour point, Flash and fire point, Neutralisation number.

#### **2.Hydraulic system**

Basic elements of hydraulic system – Oil reservoir pump unit – Principles of working of Positive displacement pump – Classifications – Gear pumps, Screw Pump, Vane pumps, Lobe pump, Simple piston pumps.

Hydraulic actuators – Classifications – Rotary – Semi-rotary – Linear motion type – Hydraulic motors – Hydraulic cylinders – types - single acting, double acting.

#### **3.Hydraulic control elements and components**

Control valves – Functions – classifications – Describe the working of pressure control valves such as relief valves - poppet valve – Direction control valves – types – sliding spool type – check valves – 1 way, 2 way, 3 way directional control valves, solenoid control valve.

Flow control valves – types – gate, globe, butterfly valves, non return valve, application circuits of control valves

Intensifier – accumulators – List the purpose of accumulators – types of accumulators – weight loaded, spring loaded, gas loaded.

#### **4.Hydraulic Circuits**

Describe with diagram automatic cylinder reciprocating circuit – hydraulic circuit for robotic arm

### **MODULE – IV**

#### **1.Pneumatic System**

Comparison of pneumatic system with hydraulic system – identification of standard pneumatic symbols – basic pneumatic system – air filter – pressure regulator – lubricator – mufflers

#### **2.Pneumatic control elements and components**

Pneumatic control valves – construction and operation of manually operated 2 way, 3 way, 4way directional control valves - solenoid valves – construction and operation of manually and cam operated flow control valves.

Air cylinders – types - light, medium, heavy, tandem, duplex, double end types

#### **3.Pneumatic circuits**

Basic pneumatic circuits – principle of working of power operated holding devices – power operated chuck, mandrel, collet and clamping circuits

#### **4.Hydro Pneumatic System**

Comparison of hydraulic, pneumatic and hydro-pneumatic system – advantages and application of combinational system of air and oil – principle of working of air controlled hydraulic valves .

### **TEXT BOOKS:**

- |                                   |                            |
|-----------------------------------|----------------------------|
| 1. Hydraulics and Fluid mechanics | - R.S.Khurmi.(S.Chand &Co) |
| 2. Basic fluid power              | - John Oster               |

### **REFERENCE BOOKS**

- |                                    |                  |
|------------------------------------|------------------|
| 1. Support materials in pneumatics | - NITTR, Chennai |
|------------------------------------|------------------|

2. Pneumatic Systems Principles and maintenance - Majumdar (Tata Mc Graw Hill)
3. Fluid Mechanics - Joseph H. Spurk. (Springer)
4. Fluid Mechanics and Pneumatics -M.R.Thomas &C.K.M.Sagir(M&C Publishers)