INDUSTRIAL FLUID FLOW OPERATION **Course Code : 314310**

Programme Name/s : **Chemical Engineering**
Programme Code : **CH**
Semester : **Fourth**
Course Title : **INDUSTRIAL FLUID FLOW OPERATION**
Course Code : **314310**

I. RATIONALE

Most of the chemical reactions in chemical or petroleum process, biological, food, pharmaceutical or polymer industries take place in liquids and gaseous phase .Due to diverse applications of fluids in various industries , it is very important to know the nature, properties and behavior of fluids. The course includes the study of behavior of fluids showing relationships between the driving forces and flow rates, transportation various process fluids, as well as the characteristics of equipment handling the fluids.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

• Measurement of flow rates of fluids by selecting the appropriate flow meter.
• Select pumping devices for transportation of fluids in Chemical industries.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the different properties of fluid used in chemical process.
- CO2 - Apply law of conservation of mass and energy to the flowing fluids.
- CO3 - Estimate the flow rate of fluid in conduit and in open channels by using different flow meters.
- CO4 - Select the appropriate pumping device for transportation of liquids in chemical industries
- CO5 - Choose the suitable pumps for transportation of gases in chemical industries.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314310	INDUSTRIAL FLUID FLOW OPERATION	IFFO	DSC	4	-	4	-	8	4	03	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 : Explain the different properties of fluids. TLO 1.2 : Measure the viscosity of liquid by using redwood viscometer. TLO 1.3 : Describe the principle of hydrostatic equilibrium TLO 1.4 Measure the differential pressure by using U-tube manometer. TLO 1.5 : Determine the relationships among physical quantities with the help of dimensional analysis	**Unit - I Fluid Properties** 1.1 Introduction to fluids and it's properties: Properties of fluids: pressure, volume, density, surface tension, capillarity, viscosity Classification of fluids: • Ideal & actual fluids • Compressible & incompressible fluids • Newtonian & non-newtonian fluids Newton's law of viscosity: Statement, derivation, absolute & kinematic viscosity, Measurement of viscosity Redwood viscometer: construction and working Numerical 1.2 Principle of hydrostatic equilibrium: Statement and derivation 1.3 Measurement of pressure: by using manometers Types : Simple U tube and U tube differential manometers, equations, simple numerical on U-tube manometer 1.4 Dimensional analysis: Importance and Dimensional homogeneity Methods of dimensional analysis : • Rayleigh • Buckingham's pi method Method of finding dimensionless numbers, Selection of variables, Common dimensionless numbers and their physical significance Numerical	Lecture using chalk-board Video demonstrations Site/Industry visit Presentations Industry expert lecture

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 State and derive the equation of continuity. TLO 2.2 State Euler's equation of motion. TLO 2.3 Derive the Bernoulli's equation. TLO 2.4 Perform the Reynold's Experiment to study the different types of flows. TLO 2.5 Evaluate the losses in pipes due to pipe fittings.	**Unit - II Flow of Incompressible Fluids** 2.1 Equation of continuity: Statement, derivation calculation of mass flow rate, volumetric flow rate, average velocity & mass velocity 2.2 Equations of motion: Eulers's equation of motion 2.3 Bernoulli's equation from Euler's equation for Ideal fluid: Statement,assumptions, derivation, corrections in Bernoulli's equation for real fluids Numerical 2.4 Reynolds experiment : Significance in determining turbulent, laminar & transition regime. Reynolds number, critical velocity Numerical 2.5 Friction in pipe: Friction Types: Form friction & skin friction, Fanning and Darcy Weisbatch friction factor, the standard friction factor chart, relation between friction factor and Reynolds number, friction losses due to sudden expansion/reduction of pipe & in pipe fittings, equivalent length of pipe, concept of Boundary layer, significance of Hagen Poiseuille equation: mathematical equation (no derivation) Numerical	Lecture using chalk-board Video demonstrations Presentations Site/Industry visit Industry expert lecture
3	TLO 3.1 Compare the flow meters. TLO 3.2 Describe with sketches the construction and working of different flowmeters. TLO 3.3 Explain the relative advantages and disadvantages of different flow meters. TLO 3.4 Measure the flow rate of process fluid in open channels by using notches and weirs.	**Unit - III Flowrate of Fluids** 3.1 Classification of flow measuring instruments in conduits: Based on variation in pressure drop: Principle, construction, working, derivation for calculating the flow rates/coefficient of discharge • Venturimeter • Orifice meter Numerical 3.2 Classification of flow measuring instruments in conduits: based on variation in flow area: Construction, principle, working and calibration • Rotameter 3.3 Measurement of local velocity : Principle, construction, working, derivation for calculating the flow rates/coefficient of discharge and numerical • Pitot tube 3.4 Advantages and Disadvantages: Venturimeter, orifice meter, rotameter and pitot tube 3.5 Measurement of flow rate of fluids in open channels: Notches and weirs: classification, construction, principle, working derivation for discharge over • Rectangular • Triangular • Trapezoidal notch or weir numerical	Lecture using chalk-board Video demonstrations Presentations Site/Industry visit Industry expert lecture

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Sketch the different pipe fittings. TLO 4.2 Select the suitable valve based on the requirements. TLO 4.3 Classify the pumps for handling liquids. TLO 4.4 Describe the construction of Centrifugal pump. TLO 4.5 Explain the working of Reciprocating Pump. TLO 4.6 Explain the construction and working of Rotary Pump.	**Unit - IV Transportation of Liquids** 4.1 Pipe and its fittings: Necessity in industry, material of construction, difference in pipes and tubes, Schedule number, Birmingham Wire Gauge, different types of pipe fittings with sketches 4.2 Valves: Construction, working and applications of • Gate valve • Globe valve • Butterfly valve • Needle valve • Ball valve • Safety valve • Rupture disc 4.3 Types of pumps used for handling liquids: Necessity, broad Classification, factors considered for selection of pump 4.4 Centrifugal pump: Principle, construction, working, cavitation, air binding, priming of pump, Net Positive Suction Head (NPSH), characteristics curve, derivation for power requirement, head developed and mechanical efficiency, advantages and disadvantages Numerical 4.5 Positive Displacement Reciprocating Pump: Principle, classification: construction, working, derivation of power required, mechanical efficiency. Numerical • Single and double acting pump • Piston and Plunger 4.6 Positive Displacement Rotary Pump: Principle, construction and working of • Mono/Screw and • Gear pump	Lecture using chalk-board Video demonstrations Presentations Site/Industry visit Industry expert lecture
5	TLO 5.1 Explain principle, construction, working and application of different gas pumping devices. . TLO 5.2 Draw the sketch of vacuum generating device TLO 5.3 Explain the concept of fluidization.	**Unit - V Pumping of Gases** 5.1 Gas pumping and devices: Need of pumping devices in industries and concept of interstage cooling 5.2 Fans: Construction, working and applications of • Induced and forced draft Fans, • Axial and centrifugal Fans 5.3 Blowers: Construction, working and applications of • Reciprocating & centrifugal blower 5.4 Compressors: Construction, working and applications of • Reciprocating & centrifugal compressors 5.5 Vacuum pump: • Steam Jet ejectors,principle,construction,working and applications 5.6 Fluidization: Basic concept, minimum fluidization velocity and applications	Lecture using chalk-board Video demonstrations Presentations Site/Industry visit Industry expert lecture

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Analyze the effect of temperature on viscosity of liquid.	1	*Determination of viscosity of a given liquid at different temperatures by using redwood viscometer	4	CO1
LLO 2.1 Find out the viscosity of given liquid samples. LLO 2.2 Measure the density of liquid by using specific gravity bottle.	2	*Calculation the viscosity of different liquids by using redwood viscometer at constant temperature.	4	CO1
LLO 3.1 Record the reading of water level in two limbs of manometer. LLO 3.2 Operate valve to change the pressure	3	*Determination of gauge pressure and differential pressure by using a set-up of U-tube manometer.	4	CO1
LLO 4.1 : Predict the nature of flow of fluid flowing through a pipe/conduit. LLO 4.2 Relate the nature of filament with corresponding calculated reynolds number	4	*Determination of various types of flows by using reynold's experiment set-up.	4	CO2
LLO 5.1 Relate pressure and velocity of fluid in a manometer tube. LLO 5.2 Observe the fluid elevation through the manometer tube at different flowrates. LLO 5.3 Operate appropriate valve to maintain steady flow.	5	*Calculation the total energy of the fluids by using experimental setup of Bernoulli's theorem.	4	CO2
LLO 6.1 Find the losses in pipes due to sudden change in diameter of pipe. LLO 6.2 Determine the associated friction factor under a range of flow rates and flow regimes(laminar or turbulent)	6	*Calculation of the head loss due to sudden expansion /sudden contraction in a given pipe.	4	CO1 CO2
LLO 7.1 Relate the pressure drop through the pipe due to frictional loss corresponding to flow rate. LLO 7.2 Measure flow rate using measuring tank.	7	Calculation of the equivalent length of the pipe fittings such as globe/gate valve, bend/elbow.	4	CO1 CO2
LLO 8.1 Use Fanning equation to calculate the losses in pipe. LLO 8.2 Plot the friction factor chart.	8	*Determination of friction factor by using friction factor set-up	4	CO1 CO2
LLO 9.1 Investigate the variation in pressure at inlet and throat at various rates.	9	Determination of pressure drop for gate/globe valve for different flow rates (different pipe diameters)	4	CO1 CO2
LLO 10.1 Investigate the variation in pressure at inlet and throat at various rates. LLO 10.2 Measure the differential pressure using manometer.	10	*Calculation of the coefficient of discharge of fluid in venturimeter	4	CO1 CO2 CO3
LLO 11.1 Investigate the variation in pressure at inlet and throat at various rates. LLO 11.2 Measure the differential pressure using manometer.	11	*Calculation of the coefficient of discharge of fluid orificemeter	4	CO1 CO2 CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Investigate the variation in pressure at inlet and throat at various rates. LLO 12.2 Measure the differential pressure using manometer.	12	*Plot the curve of area vs float position vs actual discharge using rotameter.	4	CO2 CO3
LLO 13.1 Investigate the variation in pressure at inlet and throat at various rates.	13	Determination of the velocity coefficient of closed-circuit pitot tube apparatus	4	CO1 CO2 CO3
LLO 14.1 Measure the flow rate of liquid in open channel.	14	Calculation the coefficient of discharge of triangular notch/rectangular notch /trapezoidal notch.	4	CO1 CO2 CO3
LLO 15.1 Perform the priming of centrifugal pump. LLO 15.2 Use Energy meter to find out energy actually supplied to pump (Input power).	15	*Determination the efficiency of a centrifugal pump and plot the characteristics curves.	4	CO1 CO4
LLO 16.1 Operate a reciprocating pump. LLO 16.2 Evaluate the mechanical efficiency of a reciprocating pump.	16	Plot the flow rate vs head developed by using the reciprocating pump.	4	CO1 CO4
LLO 17.1 : Use fluidized bed to determine the fluidization velocity for bed of solid materials. LLO 17.2 Observe behavior of solid with changes in gas flow rate	17	Determination of the fluidization velocity for the bed of solid materials by using fluidized bed	4	CO1 CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Redwood Viscometer Stainless steel bath with electrical heating arrangement suitable to operate at 220 Volts AC Mains with tap, oil cup with precision stainless steel jet, cup cover, Ball valve, thermometer clip. Stirrer and M.S. Sheet stand with digital indicator, Controller & FHP motor with lighting arrangement.	1,2

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	Experimental setup of Venturimeter: . Venturi meter: Body Material Acrylic, compatible to 1" Dia. Pipe. . . • Water Circulation: ½ HP Pump, Crompton/Standard Make. . • Flow Measurement: Using Measuring Tank with piezometer Capacity 25 Ltrs. . • Sump Tank: Capacity 50 Ltrs. . • Stop Watch : Electronic . • Pressure measurement : By Pressurized differential pressure manometer . • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc.	10
3	Experimental setup of Orifice meter: • Orifice meter: Body Material Acrylic, compatible to 1" Dia. Pipe. Orifice plate made of Stainless Steel . • Water Circulation: ½ HP Pump, Crompton/Standard Make. • Flow Measurement: Using Measuring Tank with piezometer Capacity 25 Ltrs. • Sump Tank: Capacity 50 Ltrs • Stop Watch : Electronic • Pressure measurement : By Pressurized differential pressure manometer • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc	11
4	Experimental setup of Rotameter: • Rotameter: Glass Tube Rotameter. • Water Circulation: ½ HP Pump, Crompton/Standard Make. • Flow Measurement: Using Measuring Tank with piezometer Capacity 25 Ltrs. • Sump Tank: Capacity 50 Ltrs. • Stop Watch : Electronic • Pressure measurement : By Pressurized differential pressure manometer • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc.	12
5	Experimental setup of notch: • Channel Test Section: Size 600 x 250 x 180 mm. • Notches : Material Brass • Rectangular Notch 45° V Notch 60° V Notch • Pointer Gauge: With Vernier scale. • Water Circulation: FHP Pump Crompton makes. • Flow Measurement: Using Measuring Tank with Piezometer, Capacity 25 Ltrs • Sump Tank: Capacity 50 Ltrs. • Stop Watch: Electronic. • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc.	13
6	Experimental setup of notch: • Channel Test Section: Size 600 x 250 x 180 mm. • Notches : Material Brass • Rectangular Notch 45° V Notch 60° V Notch • Pointer Gauge: With Vernier scale. • Water Circulation: FHP Pump Crompton makes. • Flow Measurement: Using Measuring Tank with Piezometer, Capacity 25 Ltrs • Sump Tank: Capacity 50 Ltrs. • Stop Watch: Electronic. • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc.	14

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
7	Centrifugal pump Test Rig: Pump: Kirloskar Make, Capacity 1 HP. Speed 2800 RPM (max.), Head 12 m (max.) • Medium Flow: Clear Water. • Drive: 1 HP DC motor. • Speed Control: Thyristor controlled. • Sump Tank: Capacity 110 Ltrs. approx. • Measuring Tank: Capacity 70 Ltrs. approx. with Piezometer. • Stop Watch: Electronic. • Pressure Gauge: Bourdon type. • Control Panel Comprises of: Energy measurement: Electronic Energy meter, L&T make. RPM measurement: Digital RPM Indicator with Proximity sensor. Standard make On/Off Switch, Mains Indicator, etc.	15
8	Reciprocating pump Test Rig: Pump: Double acting, Single Cylinder, Capacity 1 HP: Speed 250 RPM (max.), Head 5 kg/cm2 (max.) • Medium Flow: Clear Water. • Drive: 1 HP DC motor. • Speed Control: Thyristor controlled. • Sump Tank: Capacity 50 Ltrs. approx. • Measuring Tank: Capacity 25 Ltrs. approx. with Piezometer. • Stop Watch: Electronic. • Pressure Gauge: Bourdon type. • Control Panel Comprises of: Energy measurement: Electronic Energy meter, L&T make. RPM measurement: Digital RPM Indicator with Proximity sensor. MCB: For overload protection. Standard make On/Off Switch, Mains Indicator, etc.	16
9	Assembly of Fixed Bed: Capacity:1 KL: Material: Stainless Steel: Material Grade:SS - Hastelloy- Nickle- Titanium: Max Pressure 6-9 kg: Mixing Arrangement STATIC MIXER: Automation Grade: Automatic	17
10	Set up of U-Tube Manometer: • Single Well Manometer: Single Tube Type. • Differential Manometer: U Tube Type. 3 • Sensitive Manometer. : Inclined Tube Type • Pressure Gauge. : Bourdon Type • Water Circulation: ½ HP Pump, Crompton/Standard make. • Sump Tank: Capacity 50 Ltrs. • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc.	3

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
11	Experimental setup of Reynolds Experiment: • Tube : Material Borosilicate Glass ID 14 mm approx., Length: 600 mm • Dye vessel : Material Stainless Steel, Capacity 1 Ltrs. (approx.) • Capillary Tube: Material Stainless Steel. • Constant Head Water Tank: Capacity 40 Ltrs. • Water Circulation: FHP Pump. • Measuring Cylinder: Capacity 1000 ml. • Stop Watch : Electronic • Sump Tank: Capacity 60 Ltrs. • Control Panel Comprises of: Standard make On/Off Switch, Mains Indicator, etc. • Tanks : Stainless Steel	4
12	Experimental setup of Bernoulli'sTheorm: Test Section: Convergent and Divergent section, Material Acrylic. • Piezometer Tubes: Material P.U. Tubes (7 Nos.) • Water Circulation: ½ HP Pump, Crompton/Standard make. • Flow Measurement : Using Measuring Tank with Piezometer, Capacity 25 Ltrs • Sump Tank: Capacity 70 Ltrs. • Inlet Tank: Capacity 20 Ltrs. with fixed overflow arrangement. • Stop Watch: Electronic. • Control Panel Comprises of: Standard make On/Off Switch, Mains Indicator, etc.	5
13	Sudden expansion/Reduction, bend/elbow Sudden Enlargement: From 15mm to 25mm • Sudden Contraction: From 25mm to 15mm. • Bend : ½" • Elbow : ½" • Ball valve : ½" • Gate valve : ½" • Water Circulation: ½ HP Pump, Crompton/Standard make. • Flow Measurement: Using Measuring Tank with Piezometer, Capacity 25 Ltrs. • Pressure Drop Measurement : Pressurized Differential Pressure manometer • Sump Tank: Capacity 50 Ltrs. • Stop Watch: Electronic. • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc.	6,7,9

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
14	Friction factor set-up: Pipes (5 Nos.) : 4 Smooth bore pipe and roughened bore pipe Diameters 1 : 19 x 16 mm Diameters 2 : 12.7 x 9.5 mm Diameters 3 : 10 x 8 mm Diameters 4 : 6 x 4 mm Diameters 5 : 19 x 16 mm (roughened) • Distance between Taping : 1 m • Fittings : Strainer, 90° Elbow, 45° Elbow, 45° Y, 90° T, Sudden Enlargement & Contraction • Valves : Gate Valve, Ball Valve, Globe Valve. • Flow Meters: Venturimeter, Orifice Meter Pitot Tube. • Manometer: For measuring pressure difference. 1 Manometer Tube Range 1000 mm of WC. 1 Manometer Tube Range 1000 mm of Hg • Pressure Tapings: 38 Nos. • Water Circulation: By Pump, Crompton/Standard make. • Flow Measurement : Using Measuring Tank, Capacity 40 liters • Sump Tank : Capacity 60 liters • Stop Watch : Electronic • Control Panel Comprises of : Standard make On/Off Switch, Mains Indicator, etc.	8

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fluid Properties	CO1	10	4	4	6	14
2	II	Flow of Incompressible Fluids	CO2	12	4	4	6	14
3	III	Flowrate of Fluids	CO3	14	2	8	6	16
4	IV	Transportation of Liquids	CO4	14	4	6	6	16
5	V	Pumping of Gases	CO5	10	2	4	4	10
Grand Total				**60**	**16**	**26**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two Term Test Examination of 30 Marks

,Term Work Assessment 25 Marks

Summative Assessment (Assessment of Learning)

- End Term Theory Examination of 70 Marks

End Term Practical Examination 25 Marks

XI. SUGGESTED COS - POS MATRIX FORM

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Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	2	2	-	2			
CO2	3	1	-	2	1	-	2			
CO3	3	2	1	2	1	1	2			
CO4	3	2	1	2	2	1	2			
CO5	3	2	1	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Robert W. Fox, Alan T. McDonald, Philip J. Pritchard	Introduction to fluid mechanics	Wiley ISBN: 9780470234501, 0470234504
2	Warren McCabe, Julian Smith, Peter Harriott	Unit Operations of Chemical Engineering	McGraw-Hill Education ISBN: 9780072848236, 0072848235
3	Shiv Kumar	Fluid Mechanics (Vol. 2) Basic Concepts and Principles	Springer International Publishing ISBN: 9783030997540, 3030997545
4	Paul J. LaNasa, E. Loy Upp	Fluid Flow Measurement A Practical Guide to Accurate Flow Measurement	Elsevier Science ISBN: 9780124095328, 0124095321
5	Franz Durst	Fluid Mechanics An Introduction to the Theory of Fluid Flows	Springer ISBN: 9783540713425, 3540713425
6	Jamal Mohammed Saleh	Fluid Flow Handbook	McGraw-Hill Companies,Incorporated ISBN: 9780071363723, 0071363726
7	R. Peter King	Introduction to Practical Fluid Flow	Elsevier Science ISBN: 9780080495842, 0080495842
8	R. K. Bansal	A Textbook of Fluid Mechanics and Hydraulic Machines	Laxmi Publications ISBN: 9788131808153, 8131808157
9	R. K. Singal	Hydraulic Machines: Fluid Machinery	I.K. International Publishing House Pvt. Limited ISBN: 9789380026015, 9380026013
10	R. S. Khurmi, N Khurmi	Hydraulics, Fluid Mechanics and Hydraulic Machines	S. Chand Limited ISBN: 9788121901628, 8121901626

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description

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Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/105101082	(Videos and Texts) Fluid Mechanics, IIT Bombay
2	https://archive.nptel.ac.in/courses/112/106/112106200/	(Videos and Texts) Fluid Dynamics and Turbomachines, IIT Madras
3	https://archive.nptel.ac.in/courses/112/105/112105269/	(Videos and Texts) Introduction to Fluid Mechanics, IIT Kharagpur
4	https://nptel.ac.in/courses/112104118	(Videos and Texts) Fluid Mechanics, IIT Kanpur
5	https://nptel.ac.in/courses/103104044	(Videos and Texts) Fluid Mechanics, IIT Kanpur
6	https://nptel.ac.in/courses/105103192	(Videos and Texts) Fluid Mechanics, IIT Guwahati

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students