Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bangalore

Course Title: **HYDRAULICS & PNEUMATICS**		
Scheme (L:T:P) : **4:0:0**	Total Contact Hours: **52**	Course Code: **15ME41T**
Type of Course: **Lectures, Self Study & Quiz**	Credit **:04**	Core/ Elective: **Core**
CIE- 25 Marks		SEE- 100 Marks

Prerequisites: Knowledge of basic mathematics and Science.

Course Objectives:

1. To gain knowledge on the fundamental aspects of fluid flow physics and properties of fluid flow and selection of hydraulic machinery for relevant applications.
2. To learn various flow measurement techniques.

Course Outcomes:

On successful completion of the course, the students will be able to:

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Understand fluid dynamics	***R/U/A***	1,2,3,10	**07**
CO2	Analyze the application of mass, momentum and energy equation in fluid flow.	***R/U/A***	1,2,3,10	**09**
CO3	Calculate and compare flow rates, pressure changes, minor and major head losses for viscous flows through pipes	***R/U/A***	1,2,3,6, 10	**06**
CO4	Evaluate the performance of Hydraulic turbines and operation and performance of centrifugal and reciprocating pumps	***U/A***	1,2,3,4,6, 10	**10**
CO5	Apply knowledge and Select, operate and maintain various hydraulic elements for a particular low cost automation application in sustainable manufacturing system and its impact on society	***R/U/A***	1,2,3,4,6, 10	**10**
CO6	Apply knowledge and Select, operate and maintain various pneumatic elements for a particular low cost automation application in sustainable manufacturing system and its impact on society.	***R/U/A***	1,2,3,4,10	**10**
		Total sessions		**52**

COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE

Unit No	Unit Name	Hour	Questions to be set for SEE/MARKS			Marks weightage	weightage (%)
			R	U	A		
1	INTRODUCTION TO HYDRAULICS	07	5	10	5	20	14
2	DYNAMICS OF FLUIDS	09	5	5	15	25	17
3	FLOW THROUGH PIPES	06	5	5	5	15	12
4	HYDRAULIC MACHINES	10	--	10	20	30	19
5	HYDRAULIC SYSTEMS	10	5	10	15	30	19
6	PNEUMATIC SYSTEMS	10	5	10	10	25	19
	Total	52	25	50	70	145	100

R-Remember; U-Understanding; A-Application

COURSE-PO ATTAINMENT MATRIX

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
MECHANICAL MEASUREMENTS	3	3	3	2	-	2	-	-	-	3

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.
If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3
If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2
If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

COURSE CONTENTS

UNITI: INTRODUCTION TO HYDRAULICS 07Hrs

Fluid- Concept and classification of fluid-Newton's law viscosity-Properties of fluid-Density, Specific gravity, Specific Weight, Specific Volume- Dynamic Viscosity, Kinematic Viscosity, Surface tension, Capillarity, Vapour Pressure, Compressibility-Fluid pressure, Pressure head, Pressure intensity-Concept of absolute vacuum, gauge pressure, atmospheric Pressure-pressure,- Simple and differential manometers, Bourdon pressure gauge.

UNTII: DYNAMICS OF FLUIDS 09Hrs

Fluid flow-Types of fluid flows-Continuity equation-Bernoulli's theorem-Venturi meter– Construction, principle of working, Coefficient of discharge, Discharge through venture meter.- Orifice meter-Pitot tube – Construction, Principle of working,- hydraulic coefficients -Numerical on Bernoulli's theorem, venturi meter, orifice meter.

UNITIII: FLOW THROUGH PIPES 06Hrs

Concepts of fluid friction- Loss of head due to friction- Minor losses in pipes -Darcy's equation and Chezy's equation for frictional losses.- -Hydraulic gradient and total gradient line.- Hydraulic power transmission through pipe- Numerical to estimate Loss of head due to friction and major and minor losses- Power transmission. Concept of water hammer in pipes.

UNIT IV: HYDRAULIC MACHINES 10Hrs

Hydraulic turbines- Classification of turbine -Construction and working principle of Pelton wheel, Francis and Kaplan turbine.-Use of Penstock, Anchor Block, Surge tank and Draft tube. Concept of cavitations in turbines- Simple Numerical on Calculation of Discharge, Work done, Power, efficiency of turbine(Exclude Francis turbine)

Pumps- classification of pumps – construction and working of Centrifugal pump- Need for priming of centrifugal pump–multistage centrifugal pump. Reciprocating pump-types-construction and working- Air Vessel-Slip-Simple Numerical on Calculation of discharge, Work done, Power, efficiency of pumps-construction and working Submersible pump

UNIT V: HYDRAULIC SYSTEM 10Hrs

Hydraulic systems- layout of oil hydraulic systems-. Advantages of hydraulic systems-Components of Hydraulic systems- Pumps– Vane pump, gear pump, screw pump,-Valves – working and symbols of Pressure control valves – pressure relief valve, Direction control valves - 3/2, 5/2 valves,-Sequence valves.-Flow control valves–Actuators- Linear Actuators – Cylinders - single acting, double acting - Hydraulic motors-Accumulators-Types.

UNIT VI: PNEUMATICSYSTEM 10Hrs

Pneumatic system- General layout of pneumatic system-Advantages of pneumatic systems-Components of pneumatic system- Compressor – Reciprocating.-construction and working of FRL unit- working and symbols of-Control Valves – Pressure regulating valves, Flow Control valves, Direction Control Valves.-Actuators - Cylinders- single acting and double acting - Air motors,- piston motor-unit- - Pneumatic Symbols- ports and positions

TEXT BOOKS

1. Bansal. R.K.,"*Fluid Mechanics and Hydraulics Machines",* 9th Edition, LaxmiPublicationsPrivate Limited, New Delhi. 2011.
2. R.S.Khurmi, *"Fluid Mechanics and Machinery",*S.Chand and Company, 2nd Edition, 2007.
3. *Hydraulics & Pneumatics* – Andrew Parr, Jaico Publishing House New Delhi.
4. *Hydraulic and Pneumatic Controls Understanding Made Easy*- K.S.Sundaram,- S.chand Company Delhi

REFERENCES

1. Ramamritham. S, "*Fluid Mechanics, Hydraulics and Fluid Machines"*, DhanpatRai&Sons,Delhi, 2004.
2. Kumar. K.L., *"Engineering Fluid Mechanics",* 7th Edition, Eurasia Publishing House PrivateLimited, New Delhi, 1995.
3. P. N Modi and S. M. Seth*, "Hydraulics and Fluid Mechanics Including Hydraulics Machines"*, 19th Edition, Standard Book House, 2013
4 Bansal R. K, "*Strength of Materials",*Laxmi Publications, New Delhi, 2012.
5. *Oil Hydraulic Systems*- Majumdar, S.R. -Tata McGraw-Hill Publication, 3/e, 2013
6. *Hydraulic and Pneumatic Controls*- Srinivasan, R.- Vijay Nicole Imprints Private Limited, 2/e, 2008
7. *Pneumatic And Pneumatics Controls* -Understanding Made Easy - K.S.Sundaram,-S.chand Company Delhi
8. *Pneumatic Systems* - Majumdar, S.R. -Tata McGraw-Hill Publication, 3/e, 2013

LIST OF SOFTWARES/ LEARNING WEBSITES:

1. www.youtube.com/watch?v=VyR8aeioQrU
2. http://www.youtube.com/watch?v=R6_q5gxf4vs
3. www.howstuffworks.com
4. . http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT- KANPUR/machine/ui/TOC.htm
5. https://www.youtube.com/watch?v=F_7OhKUYV5c&list=PLE17B519F3ACF9376
6. https://www.youtube.com/watch?v=zOJ6gWDMTfE&list=PLC242EBB626D5FFB5
7. http://www.youtube.com/watch?v=0p03UTgpnDU
8. http://www.youtube.com/watch?v=A3ormYVZMXE
9. http://www.youtube.com/watch?v=TjzKpke0nSU
10. http://www.youtube.com/watch?v=vl7GteLxgdQ
11. http://www.youtube.com/watch?v=cIdMNOysMGI
12. www.boschrexroth.co.in
13. http://www.automationstudio.com/
14. http://www.howstuffworks.com/search.php?terms=hydraulics
15. http://hyperphysics.phy-astr.gsu.edu/hbase/fluid.html#flucon
16. http://www.youtube.com/watch?v=FVR7AC8ExIM
17. http://www.youtube.com/watch?v=iOXRoYHdCV0
18. http://www.youtube.com/watch?v=qDinpuq4T0U
19. http://www.youtube.com/watch?v=xxoAm3X4iw0
20. www.festo.com
21. www.boschrexroth.co.in
22. www.nptel.iitm.ac.in
23. http://www.howstuffworks.com/search.php?terms=pneumatics

24. http://www.youtube.com/watch?v=MbKrIieogNc
25. http://www.youtube.com/watch?v=7JuNbHb5NrQ
26. http://www.youtube.com/watch?v=NakOoD-G0IY
27. http://www.youtube.com/watch?v=bG2mCiQgbwE
28. http://www.youtube.com/watch?v=cB3OCPqmUDQ
29. http://www.youtube.com/watch?v=5q7YasmwXCs
30. http://www.youtube.com/watch?v=a5Ebx__l5-g

Course Delivery:

- The course will be delivered through lectures and Power point presentations/ Video
- Teachers can prepare or download ppt of different topic's Hydraulic power engineering application, can prepare alternative slides.

- Prepare/Download a dynamic animation to illustrate the following:
  • Working principle of hydraulic pumps/Hydraulic devices
  • Working principle of hydraulic valves and actuators/ Pneumatic valves and actuators

SUGGESTED LIST OF STUDENT ACTIVITYS

Note: the following activities or similar activities for assessing CIE (IA) for 5 marks (Any one)

- Each student should do any one of the following type activity or similar activity related to the course and before take up, get it approved from concerned Teacher and HOD.
- Each student should conduct different activity and no repeating should occur

1	Each student will give an activity to prepare a tabulated summary for types of fluid which is available around city (Summary includes properties of fluid indicated in chapter-1)
2	List out any five pressure measuring devices available in market with its specifications and current market price.
3	Each student will give an activity to prepare a tabulated summary for types of pipes available in market. (Summary includes type, specification, size range, material, rate and applications).
4	Identify any one hydraulic pump and one prime mover available in market in a group of five students with detail specifications and current price.
5	Visit a nearby related Earth moving equipments service centre and prepare a summary of hydro-pneumatic devices used along with their specifications
6	Motivate student to take case study on Low Cost Automation to inculcate self and continuous learning

- **MODEL OF RUBRICS /CRITERIA FOR ASSESSING STUDENT ACTIVITY**

RUBRICS FOR ACTIVITY(5 Marks)						
Dimension	**Unsatisfactory**	**Developing**	**Satisfactory**	**Good**	**Exemplary**	**Student Score**
	1	**2**	**3**	**4**	**5**	
Collection of data	Does not collect any information relating to the topic	Collects very limited information; some relate to the topic	Collect much information; but very limited relate to the topic	Collects some basic information; most refer to the topic	Collects a great deal of information; all refer to the topic	Ex: 4

Fulfil team's roles & duties	Does not perform any duties assigned to the team role	Performs very little duties but unreliable.	Performs very little duties	Performs nearly all duties	Performs all duties of assigned team roles	5
Shares work equally	Always relies on others to do the work	Rarely does the assigned work; often needs reminding	Usually does the assigned work; rarely needs reminding	Normally does the assigned work	Always does the assigned work without having to be reminded.	3
Listen to other Team mates	Is always talking; never allows anyone else to speak	Usually does most of the talking; rarely allows others to speak	Talks good; but never show interest in listening others	Listens, but sometimes talk too much	Listens and speaks a fair amount	2
				Average / Total marks=(4+5+3+2)/4=14/4=3.5=4		

Note: This is only an example. Appropriate rubrics/criteria may be devised by the concerned faculty (Course Coordinator) for assessing the given activity.

Course Assessment and Evaluation Scheme:

	What		To whom	When/Where (Frequency in the course)	Max Marks	Evidence collected	Course outcomes
Direct Assessment	CIE	IA	Students	Three IA tests(Average of three tests will be computed)	20	Blue books	1,2,3,4,5,6
				Student Activities	05	Activity sheets	
	SEE	End Exam		End of the course	100	Answer scripts at BTE	1,2,3,4,5,6
Indirect Assessment	Student Feedback on course		Students	Middle of the course		Feedback forms	1 & 2,3 Delivery of course
	End of Course Survey			End of the course		Questionnaires	1,2,3,4,5,6 Effectiveness of Delivery of instructions & Assessment Methods

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No	**Bloom's Category**	**% Weightage**
1	**Understanding**	**45**
2	**Applying the knowledge acquired from**	**25**
3	**Analysis**	**20**
4	**Evaluation& Creating new knowledge**	**10**

Note to IA verifier**: **The following documents to be verified by CIE verifier at the end of semester

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Method

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th weak of sem 10-11 Am	I/II SEM	**HYDRAULICS & PNEUMATICS**	20
	Year:		
Name of Course coordinator : CO's:____			Units:__

Question no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER

4- Semester Diploma Examination

HYDRAULICS AND PNEUMATICS

Time: **3 Hours**] [Max Marks**: 100**

Note: Answer any SIX from Part A and any SEVEN from Part B

Part A 6x5=30 marks

1. List the different properties of the fluid.
2. Define the following

i) Laminar flow ii) Turbulent flow,

iii)Steady flow iv) Uniform flow

3.Identify major energy losses and minor energy losses.

4.State the applications of Hydraulics system.

5.Explain manometer and classify.

6.Classify of control valves.

7.Explain the general layout of pneumatic system.

8.The water is flowing through a pipe having diameters 200 mm and 100 mm at sections 1 and 2 respectively. The rate of flow through pipe is 35 litres/sec. The section 1 is 6 m

above datum and section 2 is 4 m above datum. If the pressure at section 1 is 39.24 X 10^4 N/m^2 ,find the intensity of pressure at section 2.

9.APelton wheel develops 2000KW under a head of 100meters, and with an overall efficiency of 85%. Find the diameter of the nozzle, if the coefficient of velocity for the nozzle is 0.98.

Part-B

10. a)Explain with neat sketch the pitot tube. 04

b)An oil of specific gravity 0.8 is flowing through a venturi meter having inlet 06diameter 200mm and throat diameter 100mm .The oil-mercury differential manometer shows a reading of 250 mm. Calculate the discharge of oil through the horizontal venturi meter. Take $C_d = 0.98$.

11.a)Indicate the factors for selection of Hydraulic turbine. 04

b)A Pelton wheel develops 2000KW under a head of 100meters, and with an overall efficiency of 85%. Find the diameter of the nozzle, if the coefficient of velocity for the nozzle is 0.98.

12. a)Write short on air motors.

b)Explain with neat sketch, the double-acting cylinder.

13.a)Sketch and explain the gear pump.

b)Sketch and explain the Spring loaded Accumulator.

14.a)Explain hydraulic gradient and total energy lines.

b)Find the loss of head, due to friction, in a pipe of 500 mm diameter and 1.5 kilometres long. The velocity of water in the pipe is 1m/s. Take co-efficient of friction as 0.005.

15.a)Classify of control valves. 4

b)Sketch and explain the 5/2 DC valve. 6

16.a) Explain the terms with units. 4

i) Dynamic viscosity ii)kinematic viscosity.

b)Illustrate the relationship between different pressure with diagram. 6

17.a)Explain the continuity equation and Bernoulli's equation. 5

b)Explain with neat sketch the working of multistage pump for high head. 5

18.a)Explain slip, negative slip and Percentage Slip of Reciprocating pump. 5

b)Explain briefly FRL unit.

19.Distinguish between : 10.

i) Steady flow and unsteady flow ii) Uniform and non uniform flow

iii) Compressible and incompressible flow iv) Rotational and irrotational flow

MODEL QUESTION BANK

4- Semester Diploma Examination

HYDRAULICS AND PNEUMATICS

CO-1:UNDERSTAND FLUID DYNAMICS

Remembrance

1. Define the following properties:
a)Density b) Weight density c) Specific volume
d)Specific gravity e) Viscosity
2. Define the following properties
a) Dynamic viscosity b)kinematic viscosity.
c)Surface tension.
3.Define Newtonian and non Newtonian fluids
4.Defineand explain Newton's law of viscosity.
5.Describe manometer. How are they classified.
6.List the different properties of the fluid.
7.Define a)Atmospheric pressure, b)Gauge pressure c)Absolute pressure.

Understanding

1. Explain the terms with units.
a) Dynamic viscosity b)kinematic viscosity.
2. Explain surface tension.
3. Explain the phenomenon of capillary tube.
4. Distinguish between ideal fluids and real fluid.
5. Distinguish between manometers and mechanical gauges and list different types
Of mechanical pressure gauges.
6.Explain manometer and classify.

Application

1 .Explain with a neat sketch explain Bourdon's tube pressure gauge.
2. Explain with a neat sketch Simple monometer.
3. Explain with a neat sketch Differential manometer.
4. Illustrate the relationship between different pressure with diagram.
5. Write different advantages and disadvantages of manometer.

CO-2:ANALYZE THE APPLICATION OF MASS, MOMENTUM AND ENERGY EQUATION IN FLUID FLOW.

Remembrance

1. Define equation of continuity.

2. Define the following
   i) Laminar flow ii) Turbulent flow,
   iii) Steady flow iv) Uniform flow
3. Define the following
   i) Compressible fluid ii) Incompressible flow
4. State Bernoulli's theorem for steady flow of an incompressible fluid.
5. State the Bernoulli's theorem. Mention the assumptions made.
6. Define continuity equation and Bernoulli's equation.
7. List the different applications of Bernoulli's theorem .
8. Define hydraulics co-efficient.

Understanding

9. Explain equation of continuity.
10. Distinguish between :
    i) Steady flow and unsteady flow ii) Uniform and nonuniform flow
    iii) Compressible and incompressible flow iv) Rotational and irrotational flow
    v) Laminar and Turbulent flow
11. Explain pitot tube.
12. Explain the continuity equation and Bernoulli's equation.

Application

13. Explain with neat sketch the pitot tube.
14. Explain the working orifice meter with neat sketch.
15. Explain the principal of venturi meter with a neat sketch.
16. Water is flowing through a pipe of 50 mm diameter under a pressure of $29.43X10^4 N/m^2$ and with mean velocity of 2.0m/s. Find the total head or total energy per unit weight of the water at a cross-section, which is 5m above the datum line.
17. A pipe through which water is flowing, is having diameters 200mm and 100mm at the cross-sections 1 and 2 respectively. The velocity of water at section 1 is given 4.0m/s. Find the velocity head at sections 1 and 2 and also rate of discharge.
18. The water is flowing through a pipe having diameters 200 mm and 100 mm at sections 1 and 2 respectively. The rate of flow through pipe is 35 litres/sec. The section 1 is 6 m above datum and section 2 is 4 m above datum. If the pressure at section 1 is $39.24 X 10^4 N/m^2$,find the intensity of pressure at section 2.
19. Water is flowing through a pipe having diameter 300 mm and 200 mm at the bottom and upper end respectively. The intensity of pressure at the bottom end is $24.525 X 10^4 N/m^2$ and the pressure at the upper end is $9.81 X 10^4 N/m^2$.Determine the difference in datum head if the rate of flow through pipe is 40 lit/sec.
20. The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 litres/sec. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher level is $19.62X10^4 N/m^2$

21. A horizontal venture meter with inlet and throat diameters 300mm and 150mm respectively is used to measure the flow of water. The reading of differential manometer connected to the inlet and throat is 200mm mercury. Determine the rate of flow. Take C_d = 0.98.
22. An oil of specific gravity 0.8 is flowing through a venturi meter having inlet diameter 200mm and throat diameter 100mm .The oil-mercury differential manometer shows a reading of 250 mm. Calculate the discharge of oil through the horizontal venturi meter. Take C_d = 0.98.
23. A horizontal venturi meter with inlet diameter 200mm and throat diameter 100mm is used to measure the flow of oil of specific gravity 0.8. The discharge of oil through venturi meter is 60 litres/sec. Find the reading of the oil-mercury differential manometer. Take C_d = 0.98.
24. A pipe through which water is flowing is having diameters 400mm and 200mm at the cross-sections 1 and 2 respectively. The velocity of water at section 1 is given 5.0 m/s. Find the velocity head at section 1 and 2 and also rate of discharge.
25. An oil of specific gravity 0.9 is flowing through a venturi meter having inlet diameter 200mm and throat diameter 100mm. The oil-mercury differential manometer shows a reading of 200mm. Calculate the discharge of oil through the horizontal venturi meter. Take C_d = 0.98.
26. The water is flowing through a pipe having diameters 200 mm and 150mm at section 1 and section 2 respectively. The rate of flow through pipe is 40 liters/sec. The section 1 is 6m above the datum line and section 2 is 3m above the datum. If the pressure at section 1 is $29.43X10^4 N/m^2$, find the intensity of pressure at section 2.
27. A horizontal venturi meter with inlet and throat diameters 300mm and 150mm respectively is used to measure the flow of water. The reading of differential manometer connected to inlet throat is 100mm of mercury. Determine the rate of flow. Take C_d = 0.98 .
28. The water is flowing through a taper pipe of length 50m having diameters 400mm at the upper end and 200mm at the lower end, at the rate of 60 liters/sec. The pipe has a slope of 1 in 40. Find the pressure at the lower end if the pressure at the higher level is $24.525X10^4 N/m^2$.
29. An orifice meter with orifice diameter 100mm is inserted in a pipe of 200mm diameter. The pressure gauges fitted upstream and downstream of orifice meter given readings of $19.62X10^4$ N/m^2 and $9.81X10^4$ N/m^2 respectively. Co-efficient of discharge for the meter is given as 0.6. Find the discharge of water through pipe.
30. An orifice meter with orifice diameter 150mm is inserted in a pipe of 300mm diameter. The pressure difference measured by mercury oil differential manometer on the two sides of the orifice meter gives a reading of 500mm of mercury. Find the rate of flow of oil of specific gravity 0.9 when the co-efficient of discharge of meter = 0.64.

CO-3: CALCULATE AND COMPARE FLOW RATES, PRESSURE CHANGES, MINOR AND MAJOR HEAD LOSSES FOR VISCOUS FLOWS THROUGH PIPES

Remembrance

1. Define loss of head in pipes due to friction.
2. Identify major energy losses and minor energy losses.
3. Describe hydraulic gradient and total energy lines.
4. State Darcy's and Chezy's formula for fluid flow through pipes.
5. Describe different types of losses in fluid flow through pipes.
6. State the condition for maximum transmission of power.
7. Describe water hammer in pipes.

Understanding

8. Explain major energy losses and minor energy losses.
9. Explain hydraulic gradient and total energy lines.
10. Explain Darcy's and Chezy's formula for fluid flow through pipes.
11. Explain different types of losses in fluid flow through pipes.
12. Explain with the help of a line diagram
    a) Hydraulic gradient line
    b) Total energy line.
13. Explain the maximum efficiency of transmission of power.
14. Explain water hammer in pipes.

Applications

1. Write short notes water hammer.
2. Write short notes on power transmission through pipes.
3. Write short notes on losses of head due to friction through pipes.
4. Find the loss of head, due to friction, in a pipe of 500 mm diameter and 1.5 kilometres long. The velocity of water in the pipe is 1m/s. Take co-efficient of friction as 0.005.
5. Water is flowing through a pipe of 1500 m long with a velocity of 0.8 m/sec. What should be the diameter of the pipe, if the loss of head due to friction is 8.7m. Take f for the pipe as 0.01.
6. It was observed that the difference of heads between the two ends of a pipe 250 metres long and 300 mm diameter is 1.5 metres. Taking Darcy's coefficient as 0.01 and neglecting minor losses, calculate the discharge through the pipe.
7. A pipe of 60 metres long and 150 mm in diameter is connected to a water tank at one end and flows freely into the atmosphere at the other end. The height of water level in the tank is 2.6 metres above the centre of the pipe. The pipe is horizontal and f = 0.01. Determine the discharge through the pipe in litres/sec., if all the minor losses are to be considered.
8. A reservoir has been built 4 km away from a college campus having 5000 inhabitants. Water is to be supplied from the reservoir to the campus. It is estimated that each inhabitant will consume 200 litres of water per day, and that half of the daily supply is pumped within 10 hours. Calculate the size of the supply main, if the loss of head due to friction in pipeline is 20 m. Assume f = 0.008.
9. Find the head lost due to friction in a pipe 1 m in diameter and 1.5 km long when the water is flowing with a velocity of 1 m/sec., by using Darcy's equation with f = 0.020.
10. Water is supplied to a town of 4,00,000 inhabitants. The reservoir is 6.4 kilometres away from the town and loss of head due to friction in pipeline is measured as 1.5 m. Calculate the size of the supply main, if each inhabitant consumes 180 litres of water per day and half of the daily supply is pumped in 8 hours. Take the frictional factor for pipeline is 0.030.

11. Calculate the discharge through a pipe of diameter 200 mm when the difference of pressure head between the two ends of a pipe 500 m apart is 4 m of water. Take the value of f = 0.009.
12. Determine the rate of flow of water through a pipe of diameter 200mm and length 50 m. When one end of the pipe is connected to a tank and other end of the pipe is open to the atmosphere. The pipe is horizontal and the height of the water in the tank is 4 m above the centre of the pipe. Consider all minor losses and take f = 0.009.
13. Water is flowing through a pipe of diameter 200mm with a velocity of 3 m/sec. Find the head lost due to friction for a length of 5 m if the coefficient of friction f = 0.021.
14. Find the head lost due to friction in a pipe of diameter 300mm and length 50 m, through which water is flowing at a velocity of 3 m/sec. Using i) Darcy formula for which f = 0.0026, ii) Chezy's formula for which C = 60.
15. Find the diameter of a pipe of length 2000 m when the rate of flow of water through the pipe is 200 litres/sec. and the head lost due to friction is 4 m. Take the value of C = 50 in Chezy's formulae.
16. A pipe of 300 m long with a diameter of 0.3 m is supplying water. Calculate the discharge of water through the pipe, the loss of head due to friction is 1.5 m. Take Darcy's coefficient as 0.01.
17. Calculate the discharge through a pipe of diameter 200mm when the difference of pressure head between the two ends of pipe 500 m apart is 4 m of water. Take the value of 'f' = 0.009.
18. Water flows through a pipe of 200 mm in diameter 60 m long with a velocity of 2.5 m/sec. Find the head loss due to friction by using Darcy's formula, assuming f = 0.005and by using Chezy's formula, assuming C = 55.
19. Find the difference in the elevations between the water surfaces in the two tanks which are connected by a horizontal pipe of diameter 300mm and length 400 m. The rate of flow of water through the pipe is 300 litres/sec. Consider all losses and take the value of f = 0.008.
20. In a power station, water is available from a reservoir at a head of 75 m. If the efficiency of transmission is 60%, find the power available when 1.25 m^3 of water flows to the station in one section.
21. Find the maximum power that can be transmitted by a power station through a hydraulic pipe of 3 kilometres long and 200 mm diameter. The pressure of water at the power station is 1500 kPa. Take f = 0.01.

22. The pressure at the inlet of a pipeline is 400 kPa and the pressure drop is 200 kPa. The pipeline is 1.5 kilometre long. If 100 KW is to be transmitted over this pipeline, find the diameter of the pipe and efficiency of transmission. Take f = 0.006.
23. A town having a population of 1,20,000 is to be supplied with water from a reservoir at 5 km distance. It is stipulated that one half of the daily supply of 150 litres per head should be delivered within 8 hours. What must be the size of the pipe to furnish the supply, if the head available is 12 metres. Take C = 45 in Chezy's formula.
24. A pipe 3.2 kilometres long and of 0.9 m diameter is fitted with a nozzle of 200 mm diameter at its discharge end. Find the velocity of water through the nozzle, if the head of water is 50 m. Take f = 0.006 for the pipe.
25. A hydro-electric plant is supplied water at the rate of 500 litres/sec., under a head of 250 m through a pipeline 3.2 kilometres long and 500 mm diameter. The pipeline terminates in a nozzle, which has a diameter of 200 mm. find the power that can be transmitted, if the Darcy's coefficient for the pipe is 0.01.

26. A pipe of 75 mm diameter and 250 m long has a nozzle of 25 mm fitted at the discharge end. If the total head of the water is 48 m, find the maximum power transmitted. Take f as 0.01 for the pipe.
27. A pipe having a diameter 300 mm and length 3500 m is used for transmission of power by water. The total head available at pipe inlet is 500 m. Find the maximum power available at the outlet of the pipe, if f = 0.006.

CO-4: EVALUATE THE PERFORMANCE OF HYDRAULIC TURBINES AND OPERATION AND PERFORMANCE OF CENTRIFUGAL AND RECIPROCATING PUMPS

Understanding

1. Classify hydraulic turbine with examples.
2. Explain with the help of a line diagram the working principle of Impulse turbine.
3. Differentiate impulse with reaction turbines.
4. Explain the concept of cavitations in turbine.
5. Explain different Efficiency turbine.
6. Explain Draft tube. Mention its types.
7. Explain a)Penstock b)Anchor block
8. Explain Surge tank and mentions its function.
9. Indicate the factors for selection of Hydraulic turbine.
10. Indicate the functions of draft tube.
11. Classify the pumps.
12. Explain the priming in centrifugal pump.
13. Classify the various Reciprocating pumps.
14. Explain slip and negative slip of the pump.
15. Explain with a line diagram the working of Submersible pump.
16. Differentiate between the centrifugal pump and reciprocating pumps.
17. Explain slip, negative slip and Percentage Slip of Reciprocating pump.
18. Explain: (i) Slip (ii) Negative slip and (iii) Coefficient of discharge in reciprocating pump.

Applications

1. Explain with the help neat sketch, the working principle of Impulse turbine.
2. Show construction and the working principle of pelton wheel.
3. Explain the construction and the working of Francis turbine with a neat sketch.
4. Explain the construction and working of Kaplan turbine with a neat sketch.
5. Explain with neat sketch the following.

a)Penstock b)Anchor Block.

6. Explain Surge tank with a neat sketch.
7. Explain surge tank with neat sketch.
8. Explain the multistage centrifugal pump with a neat sketch.

9. Explain with a neat sketch, constructional details and principle ofoperation of a centrifugal pump.
10. Explain with neat sketch the working of multistage pump for high head.
11. Explain with neat sketch the working of multistage pump for high discharge.
12. Explain with a neat sketch the construction and working of Single acting Reciprocating pump.
13. Explain with a neat sketch the construction and working of Double acting Reciprocating pump.
14. Explain with a neat sketch air vessel and its functions.
15. Write about Reciprocating pump and Mention its types.
16. Explain with a line diagram the working of Submersible pump.
17. A Pelton wheel develops 2000KW under a head of 100meters, and with an overall efficiency of 85%. Find the diameter of the nozzle, if the coefficient of velocity for the nozzle is 0.98.
18. A Pelton wheel, having semicircular buckets and working under a head of 140meters, is running at 600rpm. The discharge through the nozzleis500 litres/sec and diameter of the wheel is 600mm. Find: a) Power available at the nozzle, b) Hydraulic efficiency of the wheel, if coefficient of velocity is 0.98.
19. A Pelton wheel, working under a head of 500 metres, produces 13000 kW at 430 r.p.m. If the efficiency of the wheel is 85%, determine a) Discharge of the turbine. b)Diameter of the wheel. c) Diameter of the nozzle. Assume suitable data.
20. In Hydro electric scheme the distance between high level reservoir at the top of the mountains and the turbine is 1.6Km and difference of their levels is 500m. The water is brought in 4 penstocks each of diameters of 0.9 metres connected to a nozzle of 200mm at the end. Find a) Power of each jet, and b) Total power available at the reservoir, taking the value of Darcy's co-efficient of friction as 0.008.
21. The Pykara power house in south India is equipped with impulse turbines of pelton type. Each turbine delivers a maximum power of 14250KW, when working under a head of 900m, and running 600rpm. Find the diameter of the jet, and the mean diameter of the wheel. Take overall efficiency of turbine as 89.2%.
22. A Pelton wheel is required to generate 3750KW under an effective head of400m. Find the total flow in litres/sec and size of the jet. Assume Generator efficiency 95%, Overall efficacy 80%, co-efficient of velocity 0.97, Speed ratio 0.46. If the jet ratio is 10, find the mean diameter of the runner.
23. The overall efficiency of a pelton wheel is 86% when the power developed is 500KW under a head of 80m. If the coefficient of velocity for the nozzle is 0.97, find the diameter of the nozzle.
24. A pelton wheel of 1m diameter is working under a head of 150m. Find the speed of the runner, if the coefficient of velocity and velocity ratio is 0.98 and 0.47 respectively.
25. A pelton wheel producing 1350KW under a head of 80m at 300 rpm. Find the diameter of the wheel, if the speed ratio is 0.45.Take $C_V = 0.98$.

26. A Kaplan turbine, operating under a net head of 20m, develops 20,000KW with an overall efficiency of 86%. The speed ratio is 2.0 and flow ratio is 0.6. The hub diameter of the wheel is 0.35 times the outside diameter of the wheel. Find the diameter and speed of the turbine.
27. A propeller turbine runner has an outer diameter of 4.5m and an inner diameter of 2.5m and develops 21,000KW when running at 140rpm. under a head of 20m. The hydraulic efficiency is 94% and overall efficiency is 88%. Find discharge through the turbine, and guide blade angle at inlet.
28. A Kaplan turbine working under a head of 5.5m develops 7500 KW. The speed ratio and flow ratio are 2.1 and 0.71 respectively. If the boss diameter is 1/3 of that of the runner and overall efficiency is 85%. Find the diameter of the runner and speed of the turbine.
29. A centrifugal pump delivers water at 30ltrs/sec to a height of 18m through a pipe of 90m long and 100mm diameter. If the overall efficiency of the pump is 75%, find the power required to drive the pump. Take f = 0.012.
30. A centrifugal pump delivers 60ltrs of water per sec to a tank situated at a height 20m. If the overall efficiency of the pump is 70%. Find the power required for the pump.
31. A centrifugal pump having an overall efficiency of 75% is discharging 30ltrs of water per sec through a pipe of 150mm diameter and 125m long. Calculate the power required to drive the pump, if the water is lifted through a height of 25m. Take coefficient friction as 0.01.
32. A double acting reciprocating pump as a stroke of 300mm and a piston of diameter 150mm. The delivery and suction head of 26m and 4m respectively including friction heads. If the pump is working at 60rpm, find power required to drive the pump with 80% efficiency.
33. A single acting reciprocating pump having a bore of 150mm diameter and Stroke of 300mm length discharges 200ltrs of water per minute. Neglecting losses, find

a) Theoretical discharge in litre/minute. b)Coefficient of dischargec)Slip of the pump.

34. A single acting reciprocating pump having cylinder diameter of 150mm and stroke 300mm is used to raise water to a total height of 30m.Find the power required to drive the pump, if the crank rotates at 60rpm.
35. A double acting reciprocating pump of plunger diameter 100mm and stroke of 250mm length is discharging water into a tank fitted 20m higher than the axis of the pump. If the pump is rotating at 45rpm, find the power required to drive the pump.

CO-5: APPLY KNOWLEDGE AND SELECT, OPERATE AND MAINTAIN VARIOUS HYDRAULIC ELEMENTS FOR A PARTICULAR LOW COST AUTOMATION APPLICATION IN SUSTAINABLE MANUFACTURING SYSTEM AND ITS IMPACT ON SOCIETY

Remembrance

1. State the advantages of Hydraulics system.
2. State the applications of Hydraulics system.
3. List the hydraulics system components.
4. Name the different types of valves used in hydraulics system.

5. Describe a)Pressure relief valve b)Direction control valve
6. Describe a)Flow control valve b)Actuators
7. State the classification of control valves.
8. Describe Accumulator.

Understand

1. Give the difference between external gear pump and lobe pump.
2. Differentiate between simple pressure relief valve and pilot operated pressure relief valve.
3. Explain is flow control valve.
4. Explain the non-return valve.
5. Classify of control valves.

Applications

1. Explain the hydraulic system with neat sketch.
2. Sketch and explain the gear pump.
3. Explain the working principle of lobe pump with neat sketch.
4. Sketch and explain the vane pump.
5. Sketch and explain the 5/2 DC valve.
6. Sketch and explain simple relief pressure valve.
7. Explain with neat sketch the pilot operated pressure relief valve.
8. Sketch and explain the pressure reducing valve.
9. Sketch and explain the non-return valve.
10. Sketch and explain the pilot operated valve.
11. Sketch and explain the pilot operated sequence valve.
17. Sketch and explain the Spring loaded Accumulator.

18. Explain with a neat sketch single acting cylinder.

19. Explain with a neat sketch double acting cylinder.

CO-6: APPLY KNOWLEDGE AND SELECT, OPERATE AND MAINTAIN VARIOUS PNEUMATIC ELEMENTS FOR A PARTICULAR LOW COST AUTOMATION APPLICATION IN SUSTAINABLE MANUFACTURING SYSTEM AND ITS IMPACT ON SOCIETY

Remembrance

1. State the applications of pneumatics.
2. State and explain the Pascal's law.
3. List the components of pneumatic system.
4. State the advantages of pneumatic system.
5. Describe are the pneumatic actuators.
6. State the applications of single-acting cylinder and double-acting cylinder.

7. List any five pneumatic symbols.
8. State the functions of FRL unit.

Understanding

1. Explain the Pascal's law.
2. Explain the pneumatic DCV with its symbolic representation.
3. Explain the pneumatic actuators.
4. Explain the general layout of pneumatic system.
5. Explain air motor.
6. Explain briefly FRL unit.

Applications

1. Sketch and explain the arrangement of pneumatic components.
2. Sketch and explain the vane compressor.
3. Explain the application of 2/2 DCV with its neat sketch.
4. Sketch and explain the 3/2 DCV.
5. What is 5/2 DCV. Explain with its neat sketch.
6. Explain with neat sketch, the single-acting cylinder.
7. Explain with neat sketch, the double-acting cylinder.
8. Explain air motor with Sketch.
9. Explain the piston motor with sketch.
10. Sketch and explain the gear motor.
11. Explain the working principle of vane motor with its neat sketch.
12. Write short on air motors.
13. Sketch the following pneumatic symbols.
    a)FRL unit b)Air motor c)3/2 Pilot valve d)Single acting actuator
    c)Flow control valve.