AURORA'S ENGINEERING COLLEGE,

MECHANICAL ENGINEERING DEPT.

FLUID MCHANICS AND HYDRAULIC MACHINERY

OBJECTIVE AND RELEVANCE

Though new methods of power generation have come up with the advances in Science, the age-old hydroelectric power generation is still under use because of its economic generation cost compared to the other sources of power. In our country, a number of hydroelectric and multipurpose projects have been undertaken in order to harness more and more power from the available water potential.

Hence, an Electrical Engineer must have a thorough knowledge of means of utilization of the hydraulic energy that is readily available through dams and reservoirs and convert it into mechanical energy for power generation. As 'Hydraulics' which was later on developed into 'Fluid Mechanics,' deals with the behaviour of fluids at rest and in motion, an exposure to the basics of this field is highly desirable for anelectrical engineer. Moreover, out of variety of types of turbines available, the knowledge of deciding which is the best option under the specified conditions of availablity of hea dand lw rates in very useful.

The science of Hydraulics / Fluid Mechanics is developed to solve the problems encountered in the fields of water supply, irrigation, navigation and water power. Today the field is a very vast one and has its wide applications even to simulate the Aerodynamic motion. However, the exposure given in this course is confined to the study of.basis as listed in the syllabus.

SCOPE

This subject gives an exposure to Electrical Engineer to the basics of fluid flows, which will help him / her in design hydraulic turbines and pumps, and in selection of turbines for a specified power output etc. The codes covers the fundamental physical principles of fluid flow, fluid static pressure, energy, means of measurement, of flow parameters. It then introduces the student to basics of hydro machinery, their operations, types, characteristics, and attributes.

PREREQUISITES

The prerequisites for this study will be basics of intermediate level Physics and rudiments of ordinary and partial differential calculus covered under Engineering Mathematics.

JNTU SYLLABUS

UNIT-I

OBJECTIVE

The objective of this fluid static is to introduce the student to the basics of Fluid Mechanics, various systems of units followed and physical properties of the fluids. Fluid kinematic meets the requirement of covering the basics of the motion of fluids and various types of fluid flows. It also includes the dynamics part of fluid flow, where the force causing the motion and the resulting motion are related.

SYLLABUS

FLUID STATICS: Dimensions and units, physical properties of fluids, specific gravity, viscosity, surface tension, vapor pressure and their influence on fluid motion, atmospheric gauge and vacuum pressure, measurement of pressure, piezometer, U-tube and differential manometers.

FLUID KINEMATICS: Stream line, path line and streak lines and stream tube, classification of flows,steady and unsteady, uniform, non-uniform, laminar, turbulent, rotational and irrotational flows, equation of continuity for one dimensional flow.

UNIT-II

OBJECTIVE

This fluid dynamic serves the need of an exposure to understand means of flow measurement. It c overs discussion of the basics of closed conduit or pipe flow, forces opposing the motion such as frictional forces and the resulting losses, losses due to geometry of the pipe, energy losses etc., It also discusses various devices used for measuring velocity, discharge etc., in fluid flows.

The objective of closed coduit flow is to introduced the principles of practice of operation of hydro machinery . The discussion covers the momentum principle used in determining the force of impact of fluid jet on stationary or moving obstructions, as they find application in the design of turbines.

SYLLABUS

FLUID DYNAMICS: Surface and body forces, Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend.

CLOSED CONDUIT FLOW: Reynold's experiment, Darcy-Weisbach equation , minor losses in pipes,pipes in series and in parallel, total energy line, hydraulic gradient line. Measurement of flow: Pitot tube, venturimeter and orifice meter, flow nozzle, turbine flow meter

UNIT-III

OBJECTIVE

This unit covers the basic aspects of setting up a hydraulic power plant such as availability of water, water head, storage, estimation of power developed from given catchment area etc.
This unit gives an insite into various types of turbines used in power generation. These are mechanical devices, which can be run by the available hydraulic energy. These, when coupled with generators, produce hydro- electric power.

SYLLABUS

BASICS OF TURBO MACHINERY: Hydrodynamic force of jets on stationary and moving flat,inclined and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

HYDROELECTRIC POWER STATIONS: Elements of hydro electric power station, types, concept of pumped storage plants, storage requirements, mass curve (explanation only) estimation of power developed from a given catchment area, heads and efficiencies.

UNIT-IV

OBJECTIVE

Thus unit helps the student to understand how to compare the performances of various turbines under given conditions and also comparison of same turbine working under different conditions. Finally the student can decide the type of turbine suitable for the given available condition.

SYLLABUS

HYDRAULIC TURBINES: Classification of turbines, impulse and reaction turbines, pelton wheel,Francis turbine and Kaplan turbine, working proportions, work done, efficiencies, hydraulic design, draft tube heory, functions and efficiency.

PERFORMANCE OF HYDRAULIC TURBINES: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.

Nothing is so simple that it cannot be misunderstood.

- **UNIT-V**

OBJECTIVE

This unit meets the need of an introduction to the pumps, which are used to increase the hydraulic energy of water or any other liquid. The function of a pump can be thought of as the reverse of function of turbines.

SYLLABUS

CENTRIFUGAL PUMPS: Classification, working, work done, manometric head , static head - losses and efficiencies,specific speed-modelanalysis, pumps in series and parallel- performance charcteristic curves, NPSH,waterhammer.

GATE SYLLABUS

UNIT-V
Hydro-electric power station

IES

UNIT-V
Hydro-electric power station

SUGGESTED BOOKS

TEXT BOOKS
T1 Hydraulics, Fluid Mechanics and Hydraulic Machinery, Modi and Seth
T2 Fluid Mechanics and Hydraulic Machines, Rajput

REFERENCE BOOKS
R1 Fluid Mechanics and fluid Power Engineering, D.S.Kumar and Kotaria, Sons.
R2 Fluid Mechanics and Machinery, D.Rama Durgaiah, New Age International.
R3 Hydraulic Machines, Banga and Sharma,
R4 Instrumentation for Engineering Measurements, James W. Dally, William E.Riley
R5 Fluid Mechanics, A.K.Jain
R6 Fluid Mechanics and Hydraulics, R.K.Bansal
R7 Fluid Mechanics, K.L.Kumar (Prentice Hall)
R8 Fluid Mechanics, Agarwal

WEBSITES

1. Stanford University: www-me.stanford.edu
2. Harvard University, U.S.A.: www.esag.harvard.edu
3. Indian Institute of Technology, Chennai: www.mech.iitm.ac.in
4. Indian Institute of Technology, Kharagpur: www.mech.iitkgp.ernet.in
5. Indian Institute of Technology, Bombay: www.me.iitb.ac.in
6. Indian Institute of Technology, Kanpur: www.iitk.ac.in
7. Indian Institute of Technology, Delhi: www.iitd.ac.in/deptt/me
8. Indian Institute of Technology, Guwahati:
9. tg.ac.in/engfac/mech/public_html/index.html
10. www.efunda.com

EXPERTS' DETAILS

INTERNATIONAL

1. Peter Bradshaw
   Faculty of Mechanics and Computation Division,
   Department of Mechanical Engineering, Stanford University, USA.
   e-mail: bradshaw@stanford.edu

2. Brian J. Centwell
Faculty of Mechanics and Computation,
Department of Mechanical Engineering, Stanford University, USA.
e-mail: cantwell@stanford.edu

3. Toshio Koike, Professor
Dept. of Civil Engineering,
University of Tokyo, Japan.
e-mail: tkoike@hydra.t.u-tokyo.ac.jp

NATIONAL

1. Dr. Eldho T.I
Associate professor,
Deaprtment of Civil engineering,
IIT Mumbai.
e-mail: eldho@civil.iitb.ac.in

2. Pranab K.Mohapatra
Associate professor,
IIT-Kanpur.
e-mail: pranab@iitk.ac.in

3. A.W.Date
Professor,
Dept of Mechanical Engineering,
IIT-Bombay.
e-mail: awdate@me.iitb.ac.in

LOCAL

1. R. Ramesh Reddy
   Professor,
   Dept. of Civil Engineering,
   OU-Hyderabad.

2. D.Shantaram
   Professor,
   Dept. of Civil Engineering,
   OU-Hyderabad.

JOURNALS

INTERNATIONAL

1. ASME Journal of Fluid Engineering
1. International Journal of Fluid Mechanics

NATIONAL

1. Institution of Engineers (India) – Civil Engineering Journal
2. Everything About Water Journal
3. ISH Journal of Hydraulic Engineering, India Society for Hydraulics

FINDINGS AND DEVELOPMENTS

1. Pressure Drop in Rectangular Microchannels as Compared with Theory Based on Arbitrary Cross Section, Mohsen Akbari, David Sinton, and Majid Bahrami J. Fluids Eng. 131, 041202 (2009) (8 pages)
2. Aerodynamic Analysis of a Vehicle Tanker ,Ramon Miralbes Buil and Luis Castejon Herrer,J. Fluids Eng. 131. 041204 (2009) (17 pages)
3. Effect of Inlet Conditions on Centrifugal Pump Performance Walid A. Aissa, International Journal of Fluid Mechanics Research, 2009, Volume. 36
4. Instantaneous Liquid Flow Rate Measurement Utilizing the Dynamics of Laminar Pipe Flow, Bernhard Manhartsgruber, J. Fluids Eng. 130, 121402 (2008) (8 pages)
5. Numerical Study of Two-Dimensional Turbulent Jets Issued from Inclined Wall Tarek Abdel-Salam, Gerald Micklow, Keith Williamson DOI: 10.1615/InterJFluidMechRes.v35.i1.50

SESSION PLAN

Sl. No	Topics in JNTU syllabus	Modules and Sub Modules	Lecture No.	Suggested Books	Remarks
		UNIT-I			
1	Fluid statics: Dimensions and units,	Objective and Relevance Development of hydraulics and fluid mechanics Physical Quantities, Dimensions and Units & System of Units	L1	T1-Ch1 R5-Ch1 R6-CH1	
2.	Physical properties of fluids specific gravity, viscosity	Specific Density, Specific Weight, Specific volume & Specific Gravity Numerical problems	L2 L 3	T1-Ch R5-Ch R6-Ch1 T1-Ch R5-Ch R6-Ch1	
3	Atmospheric gauge and vacuum pressure, Surface tension vapor pressure and their influence on fluid motion	Atmospheric, absolute, gauge and vacuum pressures, Surface tension and vapour pressure	L 4	T1-Ch2 R5-Ch2 R6-Ch2	
4.	Measurement of pressure with Piezometer, U-tube and differential manometers	Pressure measuring devices, Piezometer numerical problems Simple U-tube manometer Differential U-tube manometer Numerical problems on differential U-tube manometers	L 5 L 6 L 7	T1-Ch2 R5-Ch2 R6,-Ch2 T1-Ch2 R5-Ch2 R6-Ch2 T1-Ch2 R5-Ch2 R-Ch	
5	Stream line, path line and streak lines and	Definitions Differential equation of a streamline	L8	T1-Ch6 R5-Ch4 R6-Ch5	
6	Steady and unsteady, uniform, non-uniform, laminar, turbulent, rotational and irrotational flows	Objective of the unit Velocity function (Lagrangian and Eulerian approach), classification of flows-steady, unsteady, uniform, non uniform, laminar, turbulent, rotational and irrotational	L 9	T1-Ch6 R5-Ch4 R6-Ch5	
7	Equation of continuity for one dimensional flow	Law of conservation of mass Derivation of continuity equation	L 10 L11	T1-Ch6 R5-Ch4 R6-Ch5	

UNIT-II					
8	Surface and body forces Euler's equation	Definitions Differential equation of a streamline Law of conservation of mass Derivation of continuity equation Surface and body forces Euler's equation and its derivation	L12	T1-Ch7 R5-Ch4 R6-Ch6	
9	Bernoulli's equation for flow along a stream line	Integration of Euler's equation Assumptions made Applications	L13	T1-Ch7 R5-Ch4 R6-Ch6	
10	momentum equation and its application on force on pipe bend	Momentum equation (x, y) Applications Problems on continuity equation, Bernoulli's equation and momentum equation	L14 L15	T1-Ch8 R5-Ch4 R6-Ch6 T1-Ch8 R5-Ch4 R6-Ch6	
11	Closed conduit flow: Reynold's experiment	Objective Closed conduit flow, hydraulic diameter Reynold's Experiment	L16	T1-Ch11 R5-Ch9 R5-Ch9	
12	Minor losses in pipes pipes and major losses	Sudden expansion Sudden contraction Pipe bends Darey's equation	L17 L18	T1-Ch11 R5-Ch9 R5-Ch9	
13	Total Energy Line	Total Energy Line & Hydraulic Gradient Line (TEL and HGL) Numerical problems on TEL and HGL	L19	T1-Ch11 R5-Ch9 R5-Ch9	

14	Measurement of flow: Pilot tube, venturimeter and orifice meter, flow nozzle.	Measurement of flow: Pitot Tube Simple pitot tubePitot static tube Venturimeter,coefficient of discourage Numerical problems Orifice Meter, coefficient of discharge Numerical problems Flow through orifices, Cv, Cc, Cd Flow nozzle, Turbine flow meter	L20 L21 L22 L23	T1-Ch7 R5-Ch4,13 R6-Ch6 T1-Ch7 R5-Ch4,13 R6-Ch6 T1-Ch7 R5-Ch4,13 R6-Ch6 T1-Ch7 R5-Ch4,13 R6-Ch7	
		UNIT-III			
15	Hydrodynamic force of jets on stationary and moving flat and inclined plates	Hydrodynamic force on moving flat and inclined plates, work done and efficiency	L24	T1-Ch20 R3-Ch2 R5-Ch1	
		Hydrodynamic force on stationary curved vane: jet striking centrally and at tip	L25	T1-Ch20 R3-Ch2 R5-Ch15	
16	Hydrodynamic force of jets on stationary and moving curved vanes: jet striking centrally and at tip, work done and efficiency	Hydrodynamic force on moving curved vane: jet striking centrally and at tip,work done and efficiency Numerical problems	L26,L27	T1-Ch20 R3-Ch2 R5-Ch15 T1-Ch20 R3-Ch2 R5-Ch15 T1-Ch20 R3-Ch2 R5-Ch15	
17	velocity diagrams, flow over radial vanes	Velocity triangles notations	L28	T1-Ch20 R3-Ch2 R5-Ch15	
		, Flow over radial vanes, inlet and outlet velocity, triangles city triangles notations	L29	T1-Ch20 R3-Ch2 R5-Ch15	

		Numerical problems Stationery vane Moving vane	L30	T1-Ch20 R3-Ch2 R5-Ch15	
18	Elements of hydro electric power station types-concept of pumped storage plant storage requirements	Elements of hydro electric power station types-concept of pumped storage plant storage requirements	L31 L32	T1- Ch 20	
19	Mass curve(explanation) estimation of power developed from a given catchment area: heads and efficiencies.		L33 L34 L35	T1- Ch 20	
UNIT-IV					
20	Classification of turbines, impulse and reaction turbines	Objective of the unit Classification of turbines: impulse and reaction turbines and other types	L 36	T1-Ch21 R5-Ch15 R3-Ch5	
21	Pelton wheel, working proportions, work done, efficiencies, hydraulic design	Pelton Wheel-working, work done and efficiency	L 37	T1-Ch21 R5-Ch15 R3-Ch5	
		Working proportion, design calculations Numerical problems	L 38	T1-Ch21 R5-Ch15 R3-Ch5	
22	Francis turbine, working proportions, work done, efficiencies, hydraulic design	Francis turbine-working, work done and efficiency	L 39	T1-Ch21 R5-Ch15 R3-Ch6	
		Working proportion, design Numerical problems	L 40	T1-Ch21 R5-Ch15 R3-Ch6	
23	Kaplan turbine, working proportions	Kaplan turbine-working proportion	L 41	T1-Ch21 R5-Ch15 R3-Ch7	

24	Draft tube theory	Draft tube theory, expression for efficiency Numerical problems	L 42 L43	T1-Ch21 R5-Ch15 R3-Ch7,8	
25	Geometric similarity, Unit and specific quantities	Objective, Geometric similarity, Unit head Unit speed, Unit discharge	L 44	T1-Ch22 R5-Ch15 R3-Ch10	
		Specific speed Numerical problems	L 45	T1-Ch22 R5-Ch15 R3-Ch10	
26	characteristic curves	Constant head Constant speed Constant efficiency	L 46	T1-Ch22 R5-Ch15 R3-Ch10	
27	governing of turbines, selection of types of turbines, cavitation	Governing of pelton wheel Governing of francis turbine	L 47	T1-Ch22 R5-Ch15 R3-Ch10	
		Cavitation factor Selection of turbines	L 48	T1-Ch22 R5-Ch15 R3-Ch10	
28	Surge tanks, water hammer	Water hammer principle Surge tank working	L 49	T1-Ch21 R3-Ch9	
		UNIT-V			
29	Classification, working, work done Manometric head	Objective, Working of centrifugal pump Types of centrifugal pump Work done by impeller Manometric head	L 50	T1-Ch24 R5-Ch15 R3-Ch11	
30	losses and efficiencies, specific speed	Losses and efficiencies Specific speed	L 51	T1-Ch24 R5-Ch15 R3-Ch11	

31	Pumps in series and parallel	Pumps in series and in parallel Numerical problems	L 52	T1-Ch24 R5-Ch15 R3-Ch11	
32	Performance characteristic curves, NPSH	Performance characteristic curves,NPSH	L 53	T1-Ch24 R5-Ch15 R3-Ch11	
33	Reciprocating pumps: Working	Working of reciprocating pumps Main components, types	L 54	T1-Ch23 R5-Ch16 R3-Ch1	
34	Discharge, slip	Work done, Coefficient of discharge, Slip, Numerical problems	L 55 L 56	T1-Ch23 R5-Ch16 R3-Ch1	
35	Indicator diagrams	Indicator diagrams with and without air nesses	L 57	T1-Ch23 R5-Ch16 R3-Ch1	

STUDENTS SEMINAR TOPICS

1. Viscosity of liquids and gases.
2. Applications of Bernoulli's equation
3. Applications of momentum equation
4. Hydro-electric power generation scenario in India
5. Performance of centrifugal pumps
6. Losses in flow through pipes.
7. Water hammer principle
8. Hydraulic turbines
9. Classification of fluid flows

QUESTION BANK

UNIT- I

1. i. What is the difference between guage pressure and absolute pressure. Explain how negative guage pressure can be measured.

ii. A sleeve 10cm long encases a vertical metal rod 3.0cm in diameter with a radial clearence of 0.02mm. When immersed in an oil of viscosity 6.0poise, the effective weight of the sleeve is 7.5N. Will the sleeve slidedown the rod and if so at what velocity? **(Apr/May 09)**

2. i. A U tube containing mercury has its right limb open to atmosphere. The left limb is full of water and is connected to a pipe containing water under the pressure, the centre of which is in level with the freesurface of mercury. Findthe pressure of water in the pipe above atmosphere, if the difference of levelof mercury in the limbs is 5.08cm.

ii. Explain the working of different types of manometers with neat sketches. **(Apr/May 09)**

3. i. Differentiate between simple manometers and differential manometers. Draw neat sketches of the manometers and explain. **(Apr/May 09)**

4. i. Discuss the influence of the following fluid properties on fluid motion
   a. Viscosity
   b. Specific gravity
   c. Surface tension
   d. Bulk modulus

ii. If the surface tension at air water interface is 0.073N/m, What is the pressure difference between inside and outside of an air bubble of diameter 0.01mm? **(Nov 08)**

5. i. What is the principle on which a peizometer works? Draw a neat sketch and explain. What are different types of the same?

ii. If the surface tension at the soap air interface is 0.088N/m, Calculate the internal pressure in a soap bubble of 3 cm diameter. **(Nov 08)**

6. i. What are the absolute and kinematic viscosities? Derive the equations for them. Discuss what factors will influence them.

ii. Estimate the pressure inside a water droplet of size of 0.3mm. Assume s=0.073N/m. **(Nov 08)**

7. Define dynamic viscosity and kinematic viscosity. What are their units? Explain the significance of viscosity on fluid motion.

8. i. State Newton's equation of viscosity and give examples of its application. .
ii. An oil of viscosity 5 poise is used for lubrication between a shaft and sleeve. The diameter of shaft is 0.5 m and it rotates at 200 rpm. Calculate the horse power lost in the oil for a sleeve length of 100 mm. The thickness of the oil film is 1.0 mm. **(Feb 08, 06 Nov 07, 06)**

9. i. The pressure at a point in a fluid is 13.6 cm of mercury vacuum. Express it in N/m2 of absolute pressure, gauge pressure and also in metres of water.
ii. A 6 m deep tank is square in plan of size 2 m x 2 m. It contains water up to a depth of 4 m and oil of relative density 0.88 for the remaining height of 2 m. Determine the pressure on the bottom of the tank.**(Feb 08)**
10. i. Define Bulk modulus of liquids. Explain a fluid flow problem where it assumes significance. ii. One cubic meter of a liquid of relative density 0.788 and bulk modulus 1.32 MPa is subjected to an increase of pressure of 4.5 N/cm2. Find the change in volume and also the final density of the liquid. **(Feb 08)**

11. i. Define surface tension . Prove that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by p = 4s/d
ii. A cubical block weighing 200 kN and having a 200 mm edge is allowed to slide down on an inclined plane making an angle of 300with the horizontal on which there is a thin film of a liquid having a viscosity of 2.1x 10-3N - s/m2. What terminal velocity will be attained if the film thickness is estimated to be 0.025 mm. **(Feb 08)**
12. i. Enunciate Newton's law of Viscosity. Explain the importance of viscosity in fluid motion. What is the effect of temperature on viscosity of water and that of air?
ii. A glass tube 20 mm in diameter contains a mercury column with water above the mercury. The surface tension of mercury in contact without water is 0.36 N/m. Determine the capillary depression of the mercury. Take 0 = 1300. **(Nov 07)**

13. i. Define surface tension. Discuss the factors affecting surface tension.
ii. A piston 9.95 cm diameter works in a cylinder 10 cm diameter, 12 cm long. The space between the two is filled with a lubricating oil of viscosity 0.65 poise. Calculate the speed of the piston through the cylinderunder the action of an axial force of 5.0 N. **(Nov 07, 06)**
14. U gives the Velocity distribution near the solid wall at a section in laminar flowU = 5 Sin(5ÀY)forY d” 0 .Compute the shear stress at a section i. Y=0
ii. Y=0.05m and iii. Y=0.1m.The dynamic viscosity of fluid is 5 poise **(Nov 06)**

15. With practical examples, explain the significance of saturation vapour pressure and surface tension. **(Mar 06)**
16. Draw a neat sketch of micro manometer. Arrive at the equation for calculating the pressure difference between two points using this device.

17.The tension of water in contact with air at 200 C is 0.073 N/m. The pressure inside a water droplet wsurfaceis 0.15kN/m2 greater than the outside pressure. Calculate the diameter of the water droplet.

18. Differentiate between absolute and gauge pressures. Calculate the pressure in N/m2 due to a column of 0.4m of
i.Water
ii. Oil of specific gravity 0.9 and
iii. Mercury.
Assume specific weight of water as 9810N/m3 . **(Mar 06)**
19. How does vapour pressure affect fluid flow? **(Mar 06)**
20. Find the torque required to rotate a shaft of diameter 50 mm at 1400 rpm concentrically with a sleeve 50.16 mm in diameter and 10 m long filled with oil. Kinematic viscosity of oil is 0.94 × 10-4 m2 /s. Specific gravity of oil is 0.85. **(Mar 06)**
21. Differentiate between simple manometers and differential manometers. **(Mar 06)**
22. Determine the gauge and absolute pressures in N/m2 at a point on the free surface and at 4 m below the free surface of water. Take atmospheric pressure as 76 cm of Hg. **(Mar 06)**
23. Define mass density, weight density, specific volume and specific gravity. **(Mar 06)**
24. A 30 cm diameter shaft revolves in a guide bearing of 60 cm long at 500 rpm. If the oil film bearing is 0.13mm and viscosity of oil is 0.05Ns/m2, find the power absorbed. **(Mar 06)**
25. Why do liquids and gases show contrast with regard to variation of viscosity with temperature?
26. Explain the working of a simple U-tube manometer. What are the advantages of this manometer over a piezometer? **(Nov 05)**
27. Carbon tetrachloride (specific gravity = 1.60) flows through a pipe. Calculate the velocity if the differential manometer attached to the pitot-static tube shows a deflection of 8 cm of mercury (specific gravity = 13.6) take the coefficient of the tube as unity. **(Nov 05)**

28. Describe with neat sketches different types of manometers. **(Nov, 05, 02, Dec, 02)**

29. Explain how vacuum pressure is measured with the help of a U-tube **(Nov 05)**
30. The barometric pressure at sea level is 760 mm of Hg while on a mountain top it is found to be 735 mm of
Hg. If the specific weight of air to assumed constant at 11.8N/m3 , calculate the height of the
31. Why is Pascal’s law inapplicable in real flow situations? **(Nov 05)**

32. Mention two important properties of fluid which affect fluid motion to a considerable extent.Elaborateyouranswer. **(Nov 05)**

33. A gas bubble 10 mm in diameter rises uniformly through a liquid of specific gravity 1.5 at a speed of 0.3 cm/s. What is the viscosity of liquid?

34. State the units and dimension of the following:
i.Specific mass
ii. Dynamic viscosity
iii.Kinematic viscosity
iv. Surface Tension **(Nov 05)**

35. What do you understand by absolute viscosity and kinematic viscosity of a liquid ? What is their relationship and units? **(Nov,Dec 02)**

UNIT-II

1. i. What are the construction details of a pitot tube and explain how it works?
ii. An oil of relative density 0.90 flows through a vertical pipe of diameter 20cm.The flow is measured by a 20cm × 10cm venturimeter. The throat is 30cm above the inlet section. A differential U tube manometer containing mercury is connected to the throat and the inlet. If coefficient of discharge is 0.99 what is the manometer reading for a flow of 50 lit/sec.

2. i. What is a pitot tube and what are its uses? Draw a neat sketch and discuss.
ii. Three pipes 300m long of 30 cm diameter, 150m long of 20cm diameter and 200 m long of 25 cm diameter are connected in series in the same order betweena high level reservoir and a low level reservoir. The friction factors for the pips are 0.018, 0.02 and 0.019 respectively. Determine the rate of flow for a difference in elevations of 15m between the two reservoirs. Account for all losses. Assume K = 0.30 for contraction.

3. In a pitot static tube the stagnation pressure is 3.0kpa and the static pressure is 3.0kpa(guage). The fluid is air (ñ=1.20kg/m3). Calculate the velocity of flow by taking the instrument coefficient as 0.98

4. i. Draw a neat sketch of a flow nozzle and explain its working. Discuss on which principle it works.
   ii. A pitot tube was used to measure the quantity of water flowing in a pipe of 0.30m diameter. The water was raised to a height of 0.25m above the centre line of pipe in the vertical limb of the tube. If the mean velocity is 0.78 times he velocity at the center and coefficient of pitot tube is 0.98, find the discharge in the pipe line. The static pressure head at the center of the pipe is 0.2m.

5. i. What are the applications of pipes in series and pipes in parallel? What are the required equations to solve the problems of pipes in series and pipes in parallel?
   ii. Three pipes as detailed below, are connected in parallel between two points: Pipe Diameter(cm) Length(m)

Pipe	Diameter(cm)	Length(m)	f
P	12	1000	0.032
Q	18	800	0.02
R	10	950	0.03

When a total discharge of 0.30 m3/sec, flows through the system, calculate the distribution of the discharge and head loss between the junctions.

6. i. What are the construction details of a pitot tube and explain how it works?
   ii. An oil of relative density 0.90 flows through a vertical pipe of diameter 20cm. The flow is measured by a 20cm × 10cm venturimeter. The throat is 30cm above the inlet section. A differential U tube manometer containing mercury is connected to the throat and the inlet. If coefficient of discharge is 0.99 what is the manometer reading for a flow of 50 lit/sec.**(Nov 08)**
7. Twoare connected by a pipeline consisting of two pipes in series, one of 15 cm diameter and 6m long reserand another of 22.5 cm diameter and 15m long. If the difference in water levels of thee reservoirs is voirs6m,
8. i. Differentiate between stagnation pressure head and static pressure head with reference to a pitot tube. Explain with the help of a neat sketch.
   ii. A venturimeter of throat diameter 5cm is fitted into a 12.5 cm diameter water pipe line. The coefficient of discharge is 0.96. Calculate the flow in the pipe line when the reading on a mercury water differential U
   tube manometer connected to the upstream and throat sections shows a reading of 20 cm. **(Nov 08)**
9. Explain how do you measure the velocity of flowing water in a stream using pitot tube**(Nov 08)**
10. i. Define Major Energy Loss and Minor Energy Loss.
   ii. Briefly explain Hydraulic Gradient Line and Total Energy Line.
   iii. The rate of flow of water through a horizontal pope is 0.3m3/sec. The diameter of the pipe is suddenly enlarged from 25cm to 50cm. The pressure intensity in the smaller pipe is 1.4Kgf /cm2. Determine loss of head due to sudden enlargement, pressure intensity in the large pipe and power lost due to enlargement. **(Feb 08)**
11. i. Describe major and minor losses in pipe flow in detail.
   ii. Discuss how friction factor various with Reynolds Number.
   iii. Two pipes one of 10cm diameter, 200m long and another 15cm diameter, 400m long are connected in parallel. The friction factors are 0.0075 for the smaller pipe and 0.006 for the large pipe. The total discharge through the system is 50 lit/sec. Find the discharge and head loss in each pipe. Neglect minor losses.
   Calculate the equivalent length of a 20cm diameter having f=0.005. **(Feb 08, Nov 07)**

12.i. Derive an equation for discharge of a venturimeter. ii. Explain why Cd of a venturimeter is more than that of orifice 13.
A horizontal venturimeter with inlet and throat diameters 300mm and mm respectively is used to measure the flow of water. The pressure intensity at inlet is 130KN/m2. While the vaccum pressure head at the throat is 350mm of mercury. Assuming that 3% of head is lost in between inlet and throat, find Cd of venturimeter and rate of flow.

13. i. Derive the Darcy-weisbach equation for friction head loss in a pipe. **(Feb 08)**
ii. Water is flowing through a horizontal pipe line 1500m long and 200mm in diameter. Pressures at the two ends of the pope line are respectively 12Kp a and 2Kpa. If f = 0.015, determine the discharge through the pipe in litres per minute. Consider only frictional loss. **(Nov 07, 06)**

14. i. Describe the principle and working of orifice meter with the help of a neat sketch.
ii In a calibration test of an orifice meter of with orifice diameter 4cm is inserted in a pipe of 10cm diameter the mercury differential U-guage connected to the meter gives a reading of 38cm when 7.5 lit/sec of water
flows through the meter. Compute the coefficient of discharge. **(Nov 07, 06)**

15. i. What do you mean by compound pipe and pipes in parallel connection. What purpose is served by using pipes in parallel connection.
ii. What do you mean by equivalent pipe.
iii. Water flows through a pipe at the rate of 1.1m3 /sec. For certain length of the pipe, the diameter is 200mm and for remaining length of the pipe diameter is 400mm. Pressure of water at the larger diameter part is 1Mpa. Determine head lost due to sudden enlargement of cross sectional area and the pressure of water in the smaller diameter part of the pipe.**(Nov 07, 06)**

16 A piping system consists of three pipes arranged in series; the lengths of the pipes are 1200m, 750m and 600 m and diameters 750 mm, 600 mm and 450 mm respectively.
i.Transform the system to an equivalent 450mm diameter pipe and
ii. Determine an equivalent diameter for the pipe, 2550m long. **(Mar 06)**

17. What is a Venturimeter? Explain the principle of venturimeter with a neat sketch **(Mar 06)**

18.An oil of relative density 0.9 flows through a vertical pipe of diameter 10cm. The flow is measured by a 20cm 10cm venturimeter. The throat is 10 cm above the inlet section. A differential U-tube manometer containing mercury is connected to the throat and the inlet. If Cd =0.99. What is the flow, for a manometer
reading of 9cm? **(Mar 06)**

19.0.07m3 /s of water flows through a pipe of 15 cm diameter which suddenly enlarges to 30 cm, and the larger diameter is at the lower end. The pressure gauge at a point 50 cm above the section of enlargement shows a pressure of 196.2kN/m2 . Determine the pressure at another point 50 cm, below the section of enlargement, if the flow is downward and the pipe is vertical. **(Mar 06)**

20.
In a smooth pipe of diameter 0.5m and length 1000m, water is flowing at the rate of 0.05 m3 /s. Assuming theKinematic viscosity of water as 0.02 stokes, find:
i. Head lost due to friction
ii. Wall shear stress and
iii. Centre -line velocity.

21. A pipeline carrying oil (specific gravity 0.8) changes in diameter from 300 mm at position A to 600 mm diameter at position B which is 5 meters at a higher level. If the pressures at positions A and B are 100kN/ m2 and 60kN/m2 respectively and the discharge is 300 litres/sec, determine the loss of head and
ii. direction of flow. **(Mar 06)**

22. i. Derive Dupit's equation for an equivalent pipe
ii. Three pipes of 400mm, 200mm and 300mm diameters have lengths of 400mm, 200mm and 300mm respectively. They are connected in series to make a compound pipe. The ends of this compound pipe are connected with two tanks where difference of water levels is 16m. Assume the friction factor as 0.005. Determine the discharge through the compound pipe neglecting minor losses

23. i. Explain the different forms of energy in a fluid.
ii. The cross-sectional area of a convergent pipe is so shaped that the velocity of flow along the centre line varies linearly from 1 m/s to 10 m/s in a distance of one metre. The pipe is inclined downward at an angle of 300 with horizontal. Determine the di_erence in pressure between the two points, assuming the specific weight of the liquid as 7.85kN/m3 . **(Mar 06)**

24. termine the diameter of the throat of a venturimeter to be introduced in a horizontal section of a 0.10m diameter main so that reading of the differential U-tube manometer is 0.60m of mercury when the

25. i. Explain pipes in series and parallel
ii. A rough pipe is of diameter 8cm. The velocity at a point 3cm from wall is 30% more than the velocity at a point 1cm from pipe wall. Determine the average height of the roughness. **(Nov 04)**

26. Water flows at the rate of 150 litres per second through a 0.015m diameter orifice in a 0.03m diameter pipe.If the pressure gauges fitted upstream and down stream of the orifice indicate readings of 2 bar and 1 bar

27. A pitot tube is mounted on an airplane to indicate the relative speed of the plane. What differential pressure intensity will the instrument register when the plane is traveling at a speed of 220km/hr in a wind blowing at 40km/hr against the direction of motion of the plane? Take specific weight of air as 11.9N/m3 . **(Nov 04)**

28. A pump is installed in a pipeline, 5cm diameter carrying oil of specific gravity 0.80. It returns oil to a 10cm diameter pipe at the same elevation with a pressure increase of 15 KN/m2 . The quantity of oil flowing in the
pipeline is 0.1 m3 /s. The motor driving the pump delivers 3 KW to the pump shaft. Calculate the loss of energy in the pump. **(Nov 04)**

29. A horizontal pipe of diameter 500mm is suddenly contracted to a diameter of 250mm. The pressure

intermities in the large and smaller pipe is 14 N/cm2 and 12 N/cm2 respectively. Find the loss of head

30. i. Water is pumped at the rate of 0.5 m3 /s through a 30cm diameter pipe upto a hill top. Hill top has an elevation of 50m, and the diameter of the pipe line reduces to 20cm. If the pump maintains a pressure of 9810 N/m2 at hill
top, what is the pressure at the foot of the hill ? What is the power required to pump the water.
ii. A pipe of 300mm diameter conveying 0.3 m3 /s of water has a right angled bend in a horizontal plane. Find the resultant force exerted on the bend if the pressure at inlet and outlet of the bend are 25 N/cm2 and 23 N/cm2 . **(Nov 04)**

31. Find the throat diameter of a venturimeter, when fitted to a horizontal main 0.15m diameter having a discharge of 30litres per second. Pressure gauges inserted at the inlet and throat indicate pressures 150kPa and 80kPa respectively. Take coefficient of discharge as 0.95. **(Nov 04)**

32. Two sharp ended pipes of diameters 50mm and 100mm respectively, each of length 100m are connected in parallel between two reservoirs which have a difference of level of 10m. If the friction factor 'f' is .005 calculate head loss due to friction.
i.Aconstantdiameterpipecarryingconstantdischarge **(Nov 04)**

. Obtain an expression for absolute pressure head at Vena-contracta for an externa mouth-piece.

34. Find the velocity of an oil through a pipe, when the difference of mercury level in a differential U-tube
manometer connected to the two tappings of the Pitot tube is 100 mm. Take coefficient of

35. What do you understand by total energy line, hydraulic gradient line, pies in series, pipes in parallel andequivalent pipe? **(Nov 02)**

36. A compound piping system consists of 1800 m of 0.50m, 1200 m of 0.40m and 600 m of 0.30 m new cast iron pipes connected in series. Convert the system to:An equivalent length of 0.4 m pipe; andii. An equivalent size pipe 3600 m long. **(Nov 02)**

37. List the Minor losses of energy in a pipe flow. **(Modi, Sethi)**

38. A pipe line of 600 mm diameter is 1.5 km long. To increase the discharge, another line of the same diameter
is introduced parallel to the first in the second half of the length. If f = 0.04 and head at inlet is 300 mm
calculate the increase in discharge. Neglect minor losses.**(Modi, Sethi)**

39. A pipe bend tapers from a diameter of 500mm at inlet to a diameter of 250mm at outlet and the flow is turned
through 750. The pressures at inlet and outlet are 3.5N/m2 and 2.5N/m2 . If the pipe is conveying oil of
specific gravity 0.85, calculate the magnitude and direction of the resultant force on the bend when the oil

40. Explain hydraulically smooth and rough turbulent flows **(Modi, Sethi)**

41. A smooth pipe of diameter 80mm and 800m long carries water at the rate of 0.5m3 /minute. Calculate the loss of head, wall shear stress and centerline velocity. Assume kinematic viscosity of water as 0.015 stokes.
Assume f = 0.0791/(Re)¼ **(Modi, Sethi)**

42. Give the complete classification of orifices with neat sketches and also explain the phenomenon of jetcontraction in orifice flow? **(Modi, Sethi)**

43. A square plate weighing 115N and of uniform thickness and 30 cm edge is hung so that horizontal jet 2 cm
diameter and having a velocity of 15 m/s impinges on the plate. The center line of the jet is 15 cm below the
upper edge of the plate, and when the plate is vertical the jet strikes the plate normally and

44. The cross-sectional area of a convergent pipe is so shaped that the velocity of flow along the centre line
varies linearly from 1 m/s to 10 m/s in a distance of one metre. The pipe is inclined downward at an angle
of 300 with horizontal. Determine the difference in pressure between the two points,

45. What are the various minor losses. Derive Darcy Weisbach equation for turbulent flow.

46. A pipe line carrying water has surface protrusions of average height 0.1mm. If the shear stress developed
is 8N/m2 , determine whether the pipe surface acts as smooth, rough or in transition. For water assume

47. Two reservoirs with a difference in water surface elevation of 10 m are connected by a pipeline ABC, which
consists of two pipes AB and BC joined in series. Pipe AB is 10 cm in diameter, 20 m long and has a value of f = 0.02. Pipe BC is of 16 cm diameter, 25m long and has a f = 0.018. The junctions with the reservoirs and between the pipes are abrupt.
i. Calculate the discharge,
ii. What difference in water elevations is necessary to have a discharge of 15 litres/sec. (include all

48. Give the complete classification of orifices with neat sketches and also explain the phenomenon of jet contraction in orifice flow? **(Modi, Sethi)**

49. i. A jet of water 50 mm in diameter issues with a velocity of 10m/sec and impinges normally on a stationary flat plate which mone in forward motion. Find the force exerted by the jet on the plate and the work done.
ii. Derive the equation for force exerted by a jet striking a stationary hemispherical vane at the centre.
(Apr/May 09)

50. i. A jet of water of diameter 60mm moving with a velocity of 40 m/sec, strikes a curved fixed symmetrical plate at the centre. Find the force exerted by the jet of water in the direction of the jet, if the jet is deflected by an angle of 160degrees at the outlet of the curved plate.
ii. Define the impact of jet, work done and efficiency, Derive the equations for a typical case of jet striking a curve plate. **(Apr/May 09)**

3. i. A jet of water strikes with a velocity of 50 m/sec a flat fixed plate inclined at 30 degrees with the axis of the jet. The cross sectional area of the plate is 100 cm2 . Find the force exerted by the jet on the plate and the ratio in which the jet gets divided after striking.
ii. Derive the equation for the impact of jet striking a curved plate at the centre when the plate is stationary.
(Apr/May 09)

4. i. A jet of oil of specific gravity 0.85 strikes a fixed curved symmetrical plate at its center and leaves at the outlet tips. The diameter of the jet is 62 mm and the velocity of the jet is 45 m/sec. If the jet is deflected by 100 degrees, calculate the force exerted on the curved plate.
ii. How do you estimate the impact of a jet striking a moving normal plate in the direction of the jet.
(Apr/May 09)

5. i. A nozzle of 56 mm diameter delivers a stream of water at 30 m/sec perpendicular to a plate that moves away from the jet at 8 m/sec. Find the work done and efficiency of the jet.
ii. Prove that the force exerted by a jet of water on a fixed curved vane when the jet strikes at the centre is F= rav2 (1+cosq) where
r = Mass density of water
a = Area of cross section of the jet
v = Velocity of the jet
q = Angle of the curved plate at the out let. **(Nov 08)**

6. A 15 cm diameter jet of water with a velocity of 20 m/sec strikes a plate normally. If the plate is moving with a velocity of 8m/sec in the direction of the jet, calculate the work done per second on the plate and the efficiency of the energy transfer.**(Nov 08)**

7. i. A jet of water of 86 mm diameter strikes a curved vane at the centre with a velocity of 30 m/sec. The curved vane is moving with a velocity of 8m/sec in the direction of the jet. Find the force exerted on the plate in the direction of the jet, power and efficiency of the jet. Assume that the plate is smooth.
ii. Explain, how you find the impact of jet striking an unsymmetrical fixed curved plate at one of the tips. **(Nov 08)**

8. i. A 15 cm diameter jet of water strikes a curved vane with a velocity of 40m/sec. The inlet angle of the vane is zero and the outlet angle is 30 degrees. Calculate the resultant force on the vane when it is moving with a velocity of 12m/sec in the direction of the jet.
ii. State the equation used to find out the impact of jet on vanes. Derive the equation for resultant thrust when a jet strikes a stationary inclined flat plate. **(Nov 08)**

9. i. Derive the expressions for force and work done per second by the jet when it strikes a flat vertical plate moving in the direction of the jet and away from the jet.
ii. A jet of water of 75mm diameter strikes a curved vane at its center with a velocity of 20m/sec. The curved vane is moving with a velocity of 8m/sec in the direction of jet. Find the force exerted on the plate in the
direction of the jet power and e ciency of the jet. Assume the plate to be smooth. **(Feb 08)**

10. i. What do you mean by impact of jet. Explain
ii. Derive an expression for force exerted by the jet on a stationary vertical plate. iii. A 10cm diameter jet of water exerts a force of 2 KN in the direction of flow against a stationary flat plate which is inclained at an angle of 300 with the axis of the stream. Find
a.Force normal to the plate b. velocity of the jet c. mass flow rate of water Kg/sec. **(Feb 08, Nov 07, 06, Mar 06)**

11. i. Derive an expression for force exerted by a jet on stationary inclined flat plate ii. A nozzle of 50mm diameter delivers a stream of water at 20m/sec perpendic- ular to a plate that moves away from the Jet at 5m/sec.find
the force on the plate b. work done and c. the efficiency of jet. **(Nov 07, 02)**

12. A wheel having radial blades has the inner and outer radii of 30 cm and 60cm respectively. The jet enters the blades at the outer tip with a velocity of 40m/s at an angle of 300 to the tangent and leaves the blades with a velocity of flow of 8m/s. If the angles of the blades at entrance and exit are respectively 450 and 350,
find the work done per kg of water entering the wheel, the speed of the wheel and its efficiency. **(Mar 06)**

13. Find an expression for the efficiency of a series of moving curved vanes when a jet of water strikes

14. A jet of water of diameter 75 mm moving with a velocity of 30m/s, strikes a curved fixed plate tangentially at one end at an angle of 300 to the horizontal. The jet leaves the plate at an angle of 200 to the horizontal. Find the force exerted by the jet on the plate in the horizontal and vertical directions. **(Mar 06)**

15. A jet of water, cross-sectional area 20cm square, issues with a velocity of 25m/s and strikes a stationary plate held at 300 to the axis of jet. Find the force exerted by the jet on the plate, and work out the components of force in the direction normal to the jet. Also find how the discharge gets distributed after striking the plate. **(Mar 06)**

thevanes at one of its tips. **(Mar 06)**

16. Show that the efficiency of a free jet striking normally as series of flat plated mounted on the periphery ofa wheel never exceeds 50%. **(Mar 06)**

17. A horizontal jet of water 5cm diameter and velocity 40m/s is deflected through an angle of 13.50 by a stationary curved vane. Assume shock less and frictionless flow, determine the magnitude and directionof the

18. A double jet Pelton wheel has specific speed of 14 and develops 1 MW. The head available from the reservoir to the nozzle is 400 m. Allowing 5% for friction loss in the pipe, calculate the speed, diameter of jets and mean diameter of the buckets. Take Cv = 0.98, speed ratio = 0.46 and overall efficiency = 82%. **(Nov 05)**

19. A square plate weighing 115N and of uniform thickness and 30 cm edge is hung so that horizontal jet 2 cm diameter and having a velocity of 15 m/s impinges on the plate. The center line of the jet is 15 cm below the upper edge of the plate, and when the plate is vertical the jet strikes the plate normally and at its center. Find what force must be applied at the lower edge of the plate in order to keep plate vertical.If the plate is allowed to swing freely, find the inclination to vertical which the plate will assume under the action of jet. **(Nov 05)**

20. A Kaplan turbine develops 15 MW power under a head of 30 m. The diameter of the boss is 0.35 times the diameter of the runner. Assuming a speed ratio of 2, a flow ratio of 0.65 and an overall efficiency of 88%, determine :
i. Diameter of the runner
ii. The speed of the turbine
iii. The specific speed **(Nov 05)**

21. i Explain different efficiences of a hydraulic bine
ii. A Pelton wheel is having a mean bucket diameter of 0.8 m and is running at 1000 rpm. he net head on the pelton wheel is 400 m. If the side clearance angle is 150 and discharge through the nozzle is 0.15 m3 /s, find the hydraulic efficiency of the turbine. **(Nov 05)**

22. Draw the general layout of a Hydro-Electric Power plant and explain the working. **(Nov 05)**

23. A horizontal jet of water strikes a flat vane inclined to the jet at an angle 'q'. Obtain the components of the force of impact of jet in the direction of jet and normal to it. if,
i. The vane is stationary and

24. A jet of water 10 sq. cm in area moving at 60m/s impinges on a series of curved vanes whose entrance and
exit angles are 300 and 1350 respectively. The angle of entry of water is 150 to the line of motion

25. A jet of water with velocity U and jet area "A" strikes a flat plate normal to it. Determine the force ofimpingement, power developed and efficiency when the plate is at rest and when the plate is permitted to move along the direction of jet at a velocity "u". What will happen if a series of

26. A horizontal jet of water with velocity of 15m/s and area 20sq.cm in section is deflected through an angle

27. Show that the efficiency of a free jet striking normally as series of flat plated mounted on the periphery of a wheel never exceeds 50%. **(Nov 04)**

28. A 5cm diameter water jet with a velocity, of 30m/s enters a stationary curved vane at 400 with horizontal and leavers at 200 with horizontal so that the total deflection angle is 1200 . Assuming the flow to be frictionless and shockless, compute the magnitudes and direction of hydrodynamic force on the vane.

(Nov 04)

29.	A square metal plate of side 90cm and weight 300N is hinged so that it can swing freely about the upper horizontal edge. A horizontal jet of water 4cm in diameter with its axis 15cm below the hinge strikes the plate and deflects it to an angle of 450 with the vertical. Determine the discharge of jet in litres per second. **(Nov 04)**
30.	A Kaplan turbine working under a head of 29m develops 1280kW. If the speed ratio is equal to 2.1, flow ratio=0.62, diameter of boss=0.34 times the diameter of the runner and overall efficiency of the turbine=89%, find the diameter of the runner and speed of the turbine. **(Nov 04)**

31. Using impulse-momentum, derive an expression for the force exerted by a moving jet of fluid on a stationary curved vane. **(Nov03)**

32.Derive an expression for the specific speed of a turbine **(Nov 03)**

33.Derive equation for the force of impact of jet

i. On a normal flat vane moving in the direction of jet

ii. On a series of normal flat vanes mounted on a wheel. The vane velocity is less than jet velocity in both cases. **(Nov 03)**

34. Obtain an expression for the force exerted by a jet of water on an inclined fixed plate in the direction of thejet. **(Nov 02)**

35. A jet of water 50 mm diameter is discharging under a constant head of 75 m. Find the force exerted by the jet on a fixed plate. Take coefficient of velocity as 0.9. **(Nov 02)**

36. Show that the force exerted by a jet of water on moving inclined Plate in the direction of jet is given by Fv = r a (V – u)2 Sin2 0, Where, a = area of jet, a = inclination of the plate with the jet, V = velocity of jet **(Nov 02)**

Unit-3

1. i. Explain firm power and secondary power in detail

ii. What are the different methods of classifying the hydroelectric power plants. Explain . **(Apr/May 09)**

2. i. What is a run off river plant. What are the different parts and arrangements of such plants? Draw a neat sketch and explain

ii. What is meant by flow duration curve and power duration curve. How do you differentiate these two curves? Also explain power duration curve in detail. **(Apr/May 09)**

3. i. Describe the status of hydroelectric power in India.

ii. Explain how the load factor, capacity factor and utilization factor interrelated. Also explain the significance of diversity factor. **(Apr/May 09)**

4. i. Explain firm power and secondary power in detail

ii. What are the different methods of classifying the hydroelectric power plants. **(Apr/May**

5. i. Explain the inherent advantages, which make Hydropower more attractive.

ii. A runoff stream with an installed capacity of 12000KW operates at 15% load factor when it serves as a peak load stat should be the lowest discharge in the stream so that the station may serve as the base load station. It is given that plant efficiency is 70% when working under a head of 18m. Also calculate maximum load factor of the plant when the discharge in the stream rises to 18 cumecs. **(Nov 08)**

i. Describe the status of hydroelectric power in India.

ii. Explain how the load factor, capacity factor and utilization factor interrelated. Also explain the significance of diversity factor. **(Nov 08)**

7. i. What is a run off river plant. What are the different parts and arrangements of such plants? Draw a

neat sketch and explain
ii. What is meant by flow duration curve and power duration curve. How do you differentiate these two curves? Also explain power duration curve in detail. **(Nov 08)**

8. i. What are valves used in a penstock. Explain with neat sketches, various types of valves with their suitability under various conditions.
ii. What is intake structures. Explain different types with the help of neat sketches. **(Nov 08)**

9. i. Explain how power potential is estimated from known hydrological particulars at a hydropower plant site on a stream.
ii. Compare different types of hydroelectric power stations stating the features and merits. Use sketches wherever necessary. List out the elements of a typical hydroelectric power station **(Feb 08, Nov 07)**

10. i. What are the elements of hydroelectric power stations? Write elaborately about any two of them with neat sketches.
ii. A turbine with an efficiency of 90% is to installed in a hydroelectric plant. The head and discharge available at the plant are 40m and 25m3/sec respectively. The turbine has to run at 120rpm. What is the power developed and what is the type of turbine based on specific speed. **(Feb 08,Nov 07)**
11. i. What are the types of hydroelectric power stations? Write about each of them.
ii. At the site where hydroelectric plant is proposed the following details are available. Calculate the power that can be developed. Available head = 28 m Catchment area = 420 Km2
Yearly rainfall = 140 cm , Rainfall utilization rate = 68%, Penstock efficiency = 94%, Turbine efficiency=80%
Generator efficiency = 84% **(Feb 08)**

12. i. What are the components of a mass curve? What are its properties? Explain how it is constructed from a hydrograph.
ii. Draw a neat sketch of a hydro power plant and show clearly the various elements. Explain about the elements clearly and elaborately. **(Feb 08)**

13. i. Write what you understand by hydroelectric power station? What are its types ? Discuss the type where water is recycled.
ii. What power can be developed at a hydropower plant site given the following details. Drainage area = 600 Km2 , Uniform rainfall over drainage area = 200 cm. Water loss in run o = 15 cm, Expected net head at the
plant = 50m. Efficiency of turbine = 98% **(Nov 07, 06)**

14. i. What is hydroelectric power station ? What are its elements? Discuss them one by one elaborately with neat sketches.
ii. A turbine works with overall efficiency of 83%. The gross head and flow rate are 88m and 20m3/sec. The frictional losses in penstock are 4m. Calculate the power developed. **(Nov 07)**
15. i. What do you understand by pumped storage type of power station ?
ii What are its merits and demerits when compared with other types ? Use sketches if necessary.
(Nov 06)

16.i. What are the types of hydroelectric power plants ? Describe elaborately about pumped storage plants. ii. The following details pertain to a hydropower plant. What is power developed in KW.Available head = 130m, Catchment area = 220Km2 ,Annual average rainfall = 150 cmPercolation and evaporation losses =
18%, Turbine efficiency = 86%,Generator efficiency = 91% **(Nov 06)**

18. i. What is the name of hydroelectric power station that uses the flow of stream as it is available ? How do you compare this with reservoir or storage type of power station ? i. Explain in detail the spillways, baffle piers and drainage gallery.

ii. Explain the various factors to be considered in the selection of a hydraulic turbine. **(May 04)**

19. i. Explain in detail the primary and secondary investigations for selection of a hydroelectric power plant
ii. What are the various advantages and disadvantages of powewr generations? **(May 04)**

20. i. What do you understand by water hammer and what are its effects on the power plant?
ii. What are the functions of a surge tank fore bay and draft tube in a hydraulic power plant? **(May 04)**

21. i. What are the functions of spillways, baffle piers and drainage gallery in a hydraulic power plant?
ii. What are storage and pond age in a power plant? **(Nov 04)**

22. What are the various factors to be considered in selecting the site for a hydroelectric power plant? **(Nov 04)**
23. What is a dam? What are the various types of dams? Explain briefly
24. Explain 1) Rock Fill Dams 2) Buttress Dams **(May 00)**
25. Write short notes on Hydrographs. **(May 00)**
26. Make a discussion on classification of hydro power plants. **(May 00)**
27. Write short notes on hydrological cycle. **(May 00)**
28. Write short notes on Stream flow measurements. **(May 00)**
29. Discuss the advantages and disadvantages of pit head power stations from the Indian contest.
30. What is pumped storage plants.
31. With the help of a line diagram explain the layout of a hydroelectric power plant. Explain the need for a surge tank and a draft tube in such a plant.
32. Explain the terms storage, pondage, and load duration curve. What is their importance in hydroelectric
33. Describe with sketches the methods of governing a pelton wheel.
34. Define Hydrology. Draw and explain the hydrological cycle.

35. Describe briefly the working of a pumped storage plant. Where can such types of plants be installed?
36. Write short notes on classification of dams.
37. Explain in detail the classification of hydro electric power plant. **(Nov 04)**
38. States the steps involved in energy conversion process. **(OU Apr 05)**
39. Define mini and hydel power plants. **(OU Apr 05)**
40. What is surge tank? Why it is important in hydel plant. **(OU Apr 05)**
41. Describe briefly the performance aspects of Francis and Kaplan turbines. **(OU Apr 05)**
42. What is a pit head power station. **(OU May 03)**
43. Write about runoff and its measurements. **(OU May 03)**
44. How do you justify the combined working of power plants? **(OU May 03)**
45. What are the parameters used to determine the performance of a power plant. **(OU May 03)**
46. How hydroelectric plants are classified. **(OU May 03)**
47. Explain the terms catchment area, rainfall and runoff. **(Nov 03)**
48. Sketch the layout of hydraulic power plant suitable for high heads. Label the various parts and explain their functions. **(May 00)**
49. Distinguish between small hydro, mini hydro and micro hydro power plants. **(OUMay 02)**
50. What are the main characteristics of a good hydro power plant site? **(OUMay 02)**
51. What are the functions of a draft tube in hydroelectric power plant? **(OUMay 02)**
52. What do you understand by run - off river power plant? How its performance is increased by introducing a pondage in the plant?
53. What do you understand by pump storage plant what are the advantages and limitations of these power
55. How the most economical capacity of hydro electric plant is decided?
56. What are the specific advantages of storage reservoir type power plant?
57. What is the purpose in carrying out the economic analysis of hydro electric power project and how it is done?

1. i. With the help of a neat diagram, explain the construction and working of Kaplan turbine.
ii. The jet of water coming out of nozzle strikes the buckets of a Pelton wheel which when stationary would deflect the jet through 1650 . The velocity of water at exit is 0.9 times at the inlet and the bucket speed is
0.45 times the jet speed. If the speed of the Pelton wheel is 300 r.p.m. and the effective head is 150 m, determine:
i.Hydraulic efficiency, and
ii. Diameter of the Pelton wheel.
Take co- efficient of velocity, Cv = 0.98 **(Apr/May 09)**

2. i. Differentiate between:
i.The impulse and reaction turbines,
ii. Radial and axial flow turbines,
iii. Inward and outward radial flow turbine, and
iv. Kaplan and propeller turbines.
ii. A Pelton wheel is having a mean bucket diameter of 0.8 m and is running at 1000 r.p.m. The net head on the Pelton wheel is 400 m. If the side clearance angle is 15 0 and discharge through nozzle is 150 litres/s,
find:
i.Power available at the nozzle, and
ii. Hydraulic efficiency of the turbine. **(Apr/May 09)**

3. i. Draw a schematic diagram of a Francis turbine and explain briefly its construction and working. ii. A Pelton wheel having a mean bucket diameter of 1.0 m is running at 1000 r.p.m. the side clearance angle is 150 and discharge through the nozzle is 0.1 m3 /s, determine power available at the nozzle and hydraulic
efficiency of the turbine. **(Apr/May 09)**

4. i. A Pelton wheel has a mean bucket speed of 12 m/s and is supplied with water at the rate of 0.7 m3/s under a head of 30 m. If the buckets deflect the jet through an angle of 1600 , find the power and the efficiency of
the turbine.
ii. An inward flow reaction turbine has external and internal diameters as 0.9 m and 0.45 m respectively. The turbine is running at 200 r.p.m. and width of turbine at inlet is 0.2 m. The velocity of flow through the runner
is constant and is equal to 1.8 m/s. The guide blades make an angle of 100 to the tangent of the wheel and discharge at the outlet of turbine is radial. Draw the inlet and outlet velocity triangles and determine:
i.Relative velocity at inlet,
ii. The runner blade angles,
iii. Width of the runner at outlet,
iv. Head at the inlet of the turbine,
v.Power developed: and
vi. Hydraulic efficiency of the turbine. **(Apr/May 09)**

5. i. Define the terms: speed ratio, flow ratio and jet ratio
ii. An inward flow reaction turbine has external and internal diameters as 1.2 m and 0.6 m respectively. The velocity of flow through the runner is constant and is equal to 1.8 m/s. Determine:
a.Discharge through the runner, and
b. Width at outlet
if the width at inlet = 20 cm **(Nov 08)**

6. A Kaplan turbine working under a head of 25 m develops 16000 kW shaft power. The outer diameter of the runner is 4 m and hub diameter is 2 m. The guide blade angle is 35. The hydraulic and overall efficiency are
90. and 85% respectively. If the velocity of whirl is zero at outlet, determine: (i) runner vane angles at inlet and outlet, and speed of turbine.
(Nov 08)

7.i. Differentiate between:
a.The impulse and reaction turbines,
b.Radial and axial flow turbines,
c.Inward and outward radial flow turbine, and
d.Kaplan and propeller turbines.
ii. A Pelton wheel is having a mean bucket diameter of 0.8 m and is running at 1000 r.p.m. The net head on the Pelton wheel is 400 m. If the side clearance angle is 150 and discharge through nozzle is 150 litres/s, find:
a.Power available at the nozzle, and
b. Hydraulic efficiency of the turbine. **(Nov 08)**

8. In a Pelton wheel the buckets deflect the jet through 1700 and the relative velocity is reduced by 12% due to bucket friction. For a speed ratio of 0.47, calculate from first principles the hydraulic efficiency of the wheel. The bucket circle diameter of the wheel is 0.9 m and there is one jet for which C_v = 0.98. The actual efficiency of the wheel is 0.9 times its theoretical efficiency. The wheel develops 1700 kW under a head of 550 m. Calculate:
i.The speed of wheel in r.p.m and
ii. The diameter of the nozzle
(Nov 08)

9. i. How will you classify the turbines? Explain
ii. A Pelton wheel is to be designed for the following specifications. Power =735.75 kW S.P. Head = 200 m, Speed = 800 r.p.m., h_0 = 0.86 and jet diameter is not to exceed one-tenth of the wheel diameter. Determine:
a.Wheel diameter,
b.The number of jets required, and
c.Diameter of the jet. Take C_v = 0.98 and speed ratio = 0.45. **(Nov 08)**

10. i. What are the working proportions of a Kaplan turbine ? Explain why draft tube is provided for a Kaplan turbine when compared with a Pelton wheel.
ii. An inward flow reaction turbine has inlet and outlet diameters of 1.2m and 0.6 m respectively. The breadth at inlet is 0.25 m and at outlet it is 0.35m. The runner speed is 250 rpm. The relative velocity at inlet is 3.5m/sec and is radial. Determine
a.The absolute velocity at inlet and its inclination to the tangent of runner
b.Discharge and
c.The velocity of flow at outlet. **(Feb 08, Nov 07)**

11. i. How does the Kaplan turbine get its name ? Explain its construction and working.
ii. Explain different efficiencies and working proportions of a Kaplan turbine in detail ? **(Feb 08)**

12. i. Explain why a Pelton wheel turbine is called an Impulse turbine with a neat sketch. Define draft tube and what are its functions.
ii. A Pelton wheel turbine develops 9000 Kw under a head of 300m. The turbine speed is 550 rpm and ratio of jet dia to wheel dia is 1/10. The hydraulic, volumetric and mechanical efficiencies are 0.98, 0.95 and 0.92 respectively. The speed ratio is 0.46 and coefficient of velocity is 0.98. Calculate the no of jets to be provided. **(Feb 08, Nov 06)**

13. i. Differentiate among radial flow, axial flow and mixed flow turbines with neat sketches. Give examples of each type.
ii. Define and explain the following associated with working of turbines. Draw neat sketches
a. Stay ring b. Guide vane wheel c. Hub d. Nozzle and spear e. Casing **(Nov 07, 06)**

.

14. i. What is jet ratio and angle of deflection of jet in hydraulic design of a Pelton wheel ? What are the hydraulic functions of casing of a Pelton wheel ?
ii. Why is the reaction turbine outlet placed above the tail water level of the cylindrical and conical draft tubes which one is preferable and why. Explain your answers with neat sketches. **(Nov 07)**

15. i. How is flow controlled and regulated in Reaction turbines and Impulse turbines ? Explain with a neat sketch
ii. State different efficiencies of a reaction turbine. What are the uses of providing a draft tube in a reaction turbine? Explain with a diagram. **(Nov 07)**

16. i. How can the turbines be classified based on their specific speeds ? Bring out the differences between reaction turbines and impulse turbines.
ii. A Pelton wheel has a mean bucket speed of 12m /sec and is supplied with water at a rate of 750 liters per second under a head of 35m. If the bucket deflects the jet through an angle of 1600, ûnd the power developed by the turbine and its hydraulic efficiency. Take the coefficient of velocity as 0.98. Neglect the friction in the bucket. **(Nov 06)**

17. i. Why is the end of a reaction turbine always kept below the tail water when compared with an impulse turbine ? Compare the functions of casings of impulse turbine and reaction turbine.
ii. A reaction turbine is 2m above the tail water level and works under a head of 25 m. The draft tube records a vacuum gauge reading of 5.3 m of water and its inlet diameter is 2.2 m. The efficiency of the draft tube is
80%. What is the power developed by the turbine with an efficiency of 90%.
(Mar 06)

18. What are the uses of a draft tube? Describe with neat sketches different types of draft tubes.
(Mar 06)

17. An inward flow turbine (reaction turbine with radial discharge) with an overall efficiency of 80% is required
to develop 150 kW. The head is 8 m; peripheral velocity of the wheel is 0.96p2gH ; the radial velocity of the
flow is 0.36p2gH . The wheel is to make 150 rpm and the hydraulic losses in the turbine are 22%
18. An inward flow reaction turbine has outer and inner diameters of the wheel as 1 m and 0.5 m respectively.
The vanes are radial at inlet and the discharge is radial. Water enters the vanes at an angle of 100.
19. A jet of water, cross-sectional area 20cm2 ,issues with a velocity of 25m/s and strikes a stationary plateheld at 300 to the axis of jet. Find the force exerted by the jet on the plate, and work out the components
20. A double jet Pelton wheel is required to generate 7500 KW when the available head at the base of thenozzle is 400 m. The jet is deflected through 1658 and the relative velocity of the jet is reduced by 15% inpassing over the buckets. Determine
i. The diameter of each jet,
ii. Total flow,

25.A quarter scale turbine is tested under a head of 12m. The full-scale turbine is to work under a head of 30m

and to run at 428rpm. Find the speed of the model. If the model develops 100kW and uses

26.A Frances turbine runner has the following data. Net Head H = 68 m; speed = 750 rpm; output power = 330

kW; hydraulic efficiency = 94% overall efficiency = 85% flow ratio = .15; breadth ratio n = 0.1. Outer

diamter is 2 times the inner diameter. 6% of circumferential area is to be occupied by the

27.A Kaplan turbine develops 60MW under a head of 25m with an overall efficiency of 90%. The speed ratio is 1.6 and flow ratio = 0.5; Hub diameter is 0.35 times the outer diameter. Find the outer diameter and speed

28. Sketch and discuss the variation of pressure and velocity through a two stages velocity compounded impulse turbine? **(OU April 03)**

29. Draw inlet and exit velocity triangles for velocity compounded two stage impulse turbine? **(OU April 03)**

30. In a Kaplan turbine, power availabe at shaft = 222500kW; Head = 20 m; Speed = 150 r.p.m.; Hydraulic efficiency = 95 percent; overall efficiency 88 percent; outer diameter of runner = 4.5 m; diameter of the hub=2 m. Assming that the turbine discharges without whirl at exit determine the runner vane angles at

31. A jet of water 50 mm in diameter having a velocity of 20 m/s, strikes normally a flat smooth plate. Determine

the thrust on the plate i. if the plate is at rest, ii. if the plate is moving in the same direction as the jet

32. A 75 mm diameter jet having a velocity of 30 m/s strikes a flat plate, the normal of which is inclined at 450

to the axis of the jet. Find the normal pressure on the plate i. when the plate is stationary ii. when the

33. A jet of water 75 mm diameter and with velocity of 20 m/s flows tangentially on to a stationary vane which

34. A 50 mm diameter jet having a discharge of 50 litres/sec impinges without shock on a series of vanes which

move in the same direction as the jet at 10 m/s the shape of each vane is such that if stationary it would deflect the jet through an angle of 1350 . Due to frictional resistance the relative velocity at outlet is 0.85 of

that of an inlet. Determine the magnitude and direction of the resultant force on vanes. **(Modi, Sethi)**

35. Explain i. Unit speed ii. Unit discharge iii. Unit power of a hydraulic turbine. Derive expressions for each ofthem. **(Modi, Sethi)**

36. What are the characteristic curves of a hydraulic turbine? How are they useful to practical Engineer? How are small scale models useful in obtaining these curves for a proposed turbine of a hydroelectric installation?

UNIT-IV

1. i. Give the range of specific speed values of the Kaplan, Francis turbines and Pelton wheels. What factors decide whether Kaplan, Francis, or a Pelton type turbine would be used in a hydroelectric project

ii. A Kaplan turbine working under a head of 25 m develops 16000 kW shaft power. The outer diameter of the runner is 4 m and hub diameter is 2 m. The guide blade angle is 35. The hydraulic and overall efficiency are and 85% respectively. If the velocity of whirl is zero at outlet, determine: (i) runner vane angles at inlet and outlet, and speed of turbine. **(Apr/May 09)**

2. i. Give the range of specific speed values of the Kaplan, Francis turbines and Pelton wheels. What factors decide whether Kaplan, Francis, or a Pelton type turbine would be used in a hydroelectric project

ii. A Kaplan turbine working under a head of 25 m develops 16000 kW shaft power. The outer diameter of the runner is 4 m and hub diameter is 2 m. The guide blade angle is 35. The hydraulic and overall efficiency are and 85% respectively. If the velocity of whirl is zero at outlet, determine: (i) runner vane angles at inlet and outlet, and speed of turbine**.** **(Apr/May 09)**

3. i. Obtain an expression for unit speed, unit discharge and unit power for a turbine.

ii. A Pelton wheel is revolving at a speed of 200 r.p.m. and develops 5886 kW S.P when working under a head of 200 m with an overall efficiency of 80%. Determine unit speed, unit discharge and unit power. The speed ratio for the turbine is given as 0.48. Find the speed, discharge and power when this turbine is working under a head of 150 m **(Apr/May 09)**

4. i. Obtain an expression for unit speed, unit discharge and unit power for a turbine.ii. A Pelton wheel is revolving at a speed of 200 r.p.m. and develops 5886 kW S.P when working under a head of 200 m with an overall efficiency of 80%. Determine unit speed, unit discharge and unit power. The speed ratio for the turbine is given as 0.48. Find the speed, discharge and power when this turbine is working under a head of 150 m.

5. hydro electric project range of specific speed values of the Kaplan, Francis turbines and Pelton Give wheels. What factors decide whether Kaplan, Francis, or a Pelton type turbine would be used in a the hydroelectric project ?

6. i. Define the terms 'unit power', 'unit speed' and 'unit discharge' with reference to a hydraulic turbine. Also derive expressions for these terms.

ii. Sketch and describe a modern method of regulation to maintain a constant speed for either
a.Pelton wheel or
b.Francis turbine. **(Nov08)**

7. i. By means of a neat sketch explain the governing mechanism of Francis Turbine.
ii. A Hydraulic turbine is to develop 845.6 kW when running at 100 r.p.m. under a head of 10 m. Work out the maximum flow rate and specific speed for the turbine if the overall efficiency at the best

operating point is
92 percent. In order to predict its performance, a 1:10 scale model is tested under a head of 6 m. What would be the speed, power output and water consumption of the model if it runs under the conditions similar to the prototype?
8. i. What is cavitation? How can it be avoided in reaction turbine?
ii. What is governing and how it is accomplished for different types of water turbines? **(Nov 08)**

9. i. What do you mean by scale ratio. What are the expressions for length scale ratio, area scale ratio and volume scale ratio ?
ii. A turbine installation develops an out put of 7000 Kw working under a head of 30m and at a speed of 200 rpm. What is its specific speed. Find its speed and power when the turbine works under a head of 10m. **(Feb 08)**

10. i. What is a surge tank ? What are its uses in a hydraulic turbine installation?
ii. A hydropower plant has to work under the following conditions. Determine the likely number of turbines of specific speed 120 for the plant.
Net head = 20m, Speed = 300 rpm, Discharge = 6 m3/sec,
Hydraulic efficiency = 97%, Volumetric efficiency = 98%
Mechanical efficiency = 92 %. (**Feb08**

11. i. Define unit power and unit speed and derive the equations for the same. What are their uses ?
ii. What is a surge tank and what are the uses of it in a hydropower turbine installation ? Explain where and how it is located with the help of a neat sketch. **(Feb 08)**

12. i. What is necessity of governing a hydraulic turbine ? Explain how the Pelton wheel turbine can be governed. ii. A turbine is working under varying conditions and the head drops down from 150m to 100m. How will the
speed , discharge and power change under constant efficiency and homologous conditions. **(Feb 08)**

13. i. What are the operating characteristic curves of hydraulic turbines ? Sketch them and explain their features and applications.
ii. A Pelton wheel turbine works under the following conditions. Calculate the power, discharge and speed when the head increases by 50%. Head = 80m Speed =240 rpm Discharge = 10 m3 / sec, h m = 0.87, hv= 0.94 and hh = 0.88. **(Nov 07)**

14. i. Explain unit speed, unit discharge and unit power of a hydraulic turbine. Derive expressions for each of them.
ii. A turbine develops 7355 Kw under a head of 24.7m at 210 rpm. What is its specific speed? If this turbine is tested in the laboratory where the head available is only 7.5m, what power will it develop and at what
speed ? **(Nov 07, 06)**

15. i. What is meant by cavitation ? What is Thoma,s cavitation factor and what is its significance for turbines? Elaborate what you understand by water hammer phenomenon in turbines.
ii. A turbine works under a head of 25m at 200 rpm and the discharge is 9m3 / sec. If the overall efficiency is 90%, determine Power generated, Specific speed of the turbine and Type of turbines. **(Nov 07, 06)**

16. i. What do you mean by selection of turbines? What are scale ratios ? Explain with neat sketches when geometric similarity is achieved between model and prototype?
ii. A Pelton wheel turbine develops a power of 1000 Kw under a head of 75m. If the head becomes 25m, what will be the power developed by the turbine. **(Nov 07, 06)**

17. i. Explain the terms specific speed and unit speed as applied to hydraulic turbines. Deduce their expres- sions. What are their practical uses.
ii. A Francis turbine operates at 163.5 rpm, under 54m head and develops 19900 KW at an efficiency of 87%.Find the characteristics if this turbine is operated under 60m head. **(Nov 06)**

18. i. What are guide vanes?
ii. Define flow ratio and speed ratio?
iii. What are the disadvantages of an outward flow turbine? **(June 04)**

19.A model is tested under a head of 11 meters. The full scale turbine is required to work under a quarter-shead of 30 meters and to run at 428 rpm. At what speed must the model be run, if it develops cale 132 hp and uses 1.08 cumec at this speed; what power will be obtained from the full scale turbine turbine? State also the type of turbine.

II-MECH -IIt Sem.-2009-10 *Aurora's Engineering College*

20. What do you mean by turbine? **(June 04)**

21. Differentiate between impulse and reaction turbines. Give examples. **(June 04)**

22. A model of a Francis turbine one-fifth of full size, develops 30.8 KW at 305 rpm, under a head of 2.5 m. Find the speed and power of full size turbine operating under a head of 6m. **(June 04)**

23. What is governing o of a pelton turbine

24. A hydroelectric pow Calcu- late the spec and suggest the typ

26. What do you mean by the characteristic curves of a turbine?

28. What is a draft tube? Give various types? **(June 04)** **(Nov 04)**

29. How can cavitation be detected and prevented and give their effects?

30. A 1/5 scale model of a reaction turbine has an output of 5 kW when tested under a head of 2 m and at a speed of 600 rpm. Find the speed and power developed by the prototype when working under a head of m. **(Nov 04)**

31. In what regions in a turbine, cavitation is likely to occur? **(Nov 04)**

32. How can cavitation be avoided? **(Nov 04)**

33. What is the difference between a propeller and a Kaplan turbine?

34. A Francis turbine works under a head of 25 m and produces 11760 kW while running at 120 rpm. The turbine has been installed at a station where atmospheric pressure is 10 m of water and vapor pressure is 0.20 m of water. Calculate the maximum height of the straight draft tube for the turbine. **(Nov 04)**

35. Tests were conducted on a Francis turbine of 8 m diameter under a head of 9 m. The turbine running at 240 rpm developed 85 kW and the water consumption was 1.2 m3 /sec. If the same turbine is operated under a head of 16 m, predict its new speed, discharge and power developed. **(Nov 04)**

36. What are the advantages of Kaplan turbine over the propeller type? **Nov-04**

37 Define speed ratio and flow ratio of a Kaplan turbine?

38 Under what conditions Kaplan turbine are suited?

39. Define Cavitation. Why does it occur and what are its effects? **(Nov 04)**

40. How will you classify the turbines? **(Modi, Sethi)**

41. What is the basis of selection of a turbine at a particular place? **(Modi, Sethi)**

42. A turbine develops 500 kW power under a head of 100 metres at 200 r.p.m. What would be its normal speed and output under a head of 81 metres?

(Modi, Sethi)

UNIT-V

1. i. How will you determine the possibility of the cavitation to occur in the instal- lation of a turbine or a pump?
ii. A single-acting reciprocating pump running at 30 r.p.m., delivers 0.012 m3 /s of water. The diameter of the piston is 25 cm and stroke length 50 cm.
Determine:
i.The theoretical discharge of the pump
ii. Co-efficient of discharge, and
iii. Slip and percentage slip of the pump.

2. i. What is the difference between single-stage and multistage pumps? Describe multistage pump with
i.impellers in parallel, and
ii. impellers in series.
ii. The diameter of an impeller of a centrifugal pump at inlet and outlet are 30 cm and 60 cm respectively. The velocity of flow at outlet is 2.5 m/s and vanes are set back at an angle of 450 at outlet. Determine the minimum starting speed of the pump if the manometric efficiency is 75%.

3. i. Show from first principle that the work saved, against friction in the delivery pipe of a single-acting reciprocating pump, by fitting an air vessel is 84.8% while for a double-acting reciprocating pump the work
saved is only 39.20%.
ii. What is negative slip in a reciprocating pump? Explain with neat sketches the function of air vessels in a reciprocating pump.
4.i. What is cavitation and what are its causes? How will you prevent the cavitation in hydraulic machines? ii. A single-acting reciprocating pump has a cylinder of a diameter 15 cm and of stroke length 30 cm. The centre of the pump is 4 m above the water surface in the sump. The atmospheric pressure head is 10.3 m
of water and pump is running at 40 r.p.m. If the length and diameter of the suction pipe are 5 m and 10 cm respectively, determine the pressure head due to acceleration in the cylinder:
i.At the beginning of the suction stroke, and
ii. ii. In the middle of suction stroke.

5. i. What do you understand by characteristic curves of a pump? What is the significance of the characteristic curves? Explain them in detail.
ii. The diameter of a centrifugal pump, which is discharging 0.035 m3 /s of water against a total head of 25 m is 0.05m. The pump is running at 1200 r.p.m. Find the head, discharge and ratio of powers of a geometrically
similar pump of diameter 0.3 m when it is running at 2000 r.p.m. **(Nov 08)**

6. i. Define indicator diagram. How will you prove that area of indicator diagram is proportional to the work done by the reciprocating pump?

ii. A centrifugal pump impeller whose external and internal diameters are 400 mm and 200 mm respectively is running at 950 r.p.m. The rate of flow through the pump is 0.035 m3 /s. the suction and delivery heads are
5 m 25 m respectively. The diameters of the suction and delivery pipes are 120 mm and 80 mm respectively. If the outlet vane angle is 450, the flow velocity is constant and equal to 1.8 m/s and power required to drive the pump is 15 kW, determine:
a.Inlet vane angle
b.The overall efficiency, and
c.The manometric efficiency.

7. i. What is the effect of acceleration in suction and delivery pipes on indicator diagram? Does the area of the indicator diagram change as compared to the area of ideal indicator diagram?
ii. A centrifugal pump impeller whose external diameter and width at the outlet are 0.8 m and 0.1 m respectively is running at 550 r.p.m. The angle of impeller vanes at outlet is 40. The pump delivers 0.98 m3 of water per second under an effective head of 35 m. If the pump is driven by a 500 kW motor, determine:
a.The manometric efficiency
b.The overall efficiency, and
c.The mechanical efficiency. Assume water enters the vanes radially at inlet **(Nov 08)**

8. i. Draw an indicator diagram, considering the effect of acceleration and friction in suction and delivery pipes. Find an expression for the work done per second in case of single-acting reciprocating pump.
ii. A single-acting reciprocating pump having a bore of 150 mm and a stroke of 300 mm is raising water to height of 20 m above the sump level. The pump has an actual discharge of 0.0052 m3/s. The efficiency of
the pump is 70%. If the speed of pump is 60 r.p.m. Determine:
a.Theoretical discharge
b.Theoretical power
c.Actual power, and
d.Percentage slip. **(Nov 08)**

9. i. Define slip and coefficient of discharge of a reciprocating pump and write the expressions for the same. What do they practically indicate?
ii. The following details refer to working of a single acting reciprocating pump. Find the slip, coefficient of discharge and theoretical power required to drive the pump.
Piston diameter = 15 cm Crank radius = 15 cm Diameter of delivery pipe = 10 cm
Discharge of the pump = 0.31 m3 /min Total lift = 15 m
Speed of the pump = 60 rpm **(Feb 08, Nov 07)**

10. i. Derive the equation for work done by the impeller of a centrifugal pump on the fluid handled. What are different efficiencies of centrifugal pump ?
ii. Explain the working of a reciprocation pump with a neat sketch showing all the components. **(Feb 08)**

11. i. List all hydraulic losses, Mechanical losses and Leakage losses of a centrifugal pump. Explain when can centrifugal pumps arranged in series and in parallel.
ii. How can you find the power required to drive a reciprocating pump ? Define slip of a reciprocating pump.
(Feb 08)
12. i. Discuss
a.Manometric efficiency b. Mechanical efficiency c. Volumetric efficiency
d.Overall efficiency and e. NPSH of a centrifugal pump.
ii. Explain how the number of pumps can be decided to be connected in series to deliver the water to a

13. i. What is NPSH ? How will it relate to the working of a centrifugal pump ? List all the losses of centrifugal pumps.
ii. Explain the working of a reciprocating pump with a neat sketch. Prove that the discharge of a single acting reciprocating pump is given by Q = ALN / 60 **(Nov 07)**

14. i. What do you understand by pumps in series and pumps in parallel ? How do you decide whether the pumps shall be used in series or parallel.
ii. A single acting reciprocating pump running at 60 rpm delivers 0.53 m3 of water per minute. The diameter of the piston is 200 mm and stroke length 300 mm. The suction and delivery heads are 4m and 12m respectively. Determine
c.Theoretical discharge b. Coefficient of dischargePercentage slip of the pump and
d.d. Power required to run the pump. **(Nov 07)**

15. i Write a detailed account about the classification of pumps. Explain the working of a centrifugal pump with a neat diagram and showing all the components.
ii. Prove that the work done by a single acting reciprocating pump is given by P = wALN(hs +hd)/60. Define slip and write its equation. **(Nov 06)**

16. i. How can head added to the water be increased in centrifugal pumps ? Explain with neat sketch.. What is NPSH and what are its uses.
ii. A single acting reciprocating pump having a bore of 150mm and a stroke of 300 mm is raising water to height of 20m above the sump level. The pump has an actual discharge of 0.0052 m3 /sec. The efficiency of the pump is 70%. If the speed of the pump is 60 rpm, determine
a.Theoretical discharge b. Theoretical power
c.Actual power and d. Percentage slip. (N**ov 06)**

20. How does a volute casing differ from a vortex casing for the centrifugal pump? **(Nov 06)**

21. What is Priming? Why is it necessary? **(Mar 06)**

23. A Centrifugal pump is running at 1000 RPM. The outlet vane angle of the impeller is 458 and velocity of flow at outlet is 2.5 m/s. The discharge through the pump is 200 litres/sec when the pump is working against a total head of 20m. If the manometric efficiency of the pump is 80%, Determine:
i. The diameter of the impeller and
ii. The width of the impeller at outlet. **(Mar 06)**

24. The impeller of a centrifugal pump has 1.2 m outside diameter. It is used to lift 1800 litres of water per second against a head of 6 m. Its vanes make an angle of 1500 with the direction of motion at outlet and runs at 200 rpm. If the radial velocity of flow at outlet is 2.5 m/s, find the manometric efficiency. Also find the lowest speed to start the pump, if the diameter of the impeller at inlet is equal to half the diameter at exit. **(Mar 06)**

.
36. i. Derive the equation for the head developed by the impeller in a centrifugal pump.
ii. Derive the equation for minimum starting speed of a centrifugal pump. **(Nov 04)**
37. i. What are necessary conditions for complete similarity to exist between model and prototype.
ii. What is specific speed of a centrifugal pump? What is its use? **(Nov 04)**
38. i. Why will the centrifugal pump function only when started at or above minimum speed?
ii. Why is the pump called centrifugal pump? How is the centrifugal action present inside the casing? **(Nov 04)**
39. i. Derive the equation for specific speed of a centrifugal pump from basics .
ii. What are the unit quantities? Derive their expressions. **(Nov 04)**
40. i. Explain the leakage losses in centrifugal pumps?
ii. The impeller tips of a centrifugal pump have radii of 10 cm and 30 cm. Determine the minimum starting speed at which delivery will commence against a static head of 15m. **(Nov 04)**

41. What are the common problems associated with the working of a centrifugal pump ? What are their remedial measures? **(Nov 04)**

42. With the help of a sketch, explain the variation of velocity and acceleration in the suction and delivery pipes due to acceleration of the piston in a reciprocating pump. **(Jun 04)**

43. i. What are the factors which influence the speed of a reciprocating pump?
ii. Show from first principle, the work saved against friction in the delivery pipe of a single-acting reciprocating pump by fitting air vessel is 84.8%. **(Jun 04)**

44. i. What is an air vessel? Describe the function of air vessel in reciprocating pumps.
ii. Find the saving in work done against friction in the delivery of a double acting reciprocating pump by fitting air vessels. **(Jun04)**

41. i. Derive an expression for the head lost due to friction in suction and delivery pipes of a reciprocating pump.
ii. Draw an indicator diagram considering the effect of acceleration and friction in suction and delivery pipes. Find an expression for the work done per second in case of single acting reciprocating pump.
(Jun 04)

42. i. What are the types of centrifugal pumps? Explain with the help of neat sketches where necessary.
ii. Draw the out let velocity triangle for radial vane of a centrifugal pump. What is preventing? Why is it needed in a centrifugal pump? **(Jun 04)**

43. A centrifugal pump runs at 800 rpm and delivers 5 m3 / sec against a head of 7 m. The impeller has an outer diameter of 25 cm and width of 5 cm at out let. If the vane angle at out let is 50° , determine the manometric efficiency. Find the specific speed. **(Jun 04)**

44. i. What are the different components of a centrifugal pump? Show them with the help of a neat sketch. ii. What is the pressure at the eye of a centrifugal pump? What is the limitation on this pressure?
(Jun 04)

45. i. Explain how the centrifugal pump is equivalent to the reverse of a reaction turbine. ii. Differentiate between
a.Mechanical efficiency b. Volumetric efficiency c. Manometric efficiency. **(Jun 04)**

46. i. What is the phenomenon of cavitation. Where will it occur in centrifugal pump?
ii. When will the kinematic similarity exist between model and prototype? **(June 04)**

47. i. What is the difference between
a.Static head and
b.Total head. Explain with the help of a sketch.
ii. Derive the equation for the work done by the impeller of a centrifugal pump. **(June 04)**

48. i. What do you understand by multistage pump? When do you use them?
ii. What do you understand by pumps in parallel? When do you connect the pumps in parallel?
(June 04)

49. Define static & manometric head of a centrifugal pump. State the different types of head losses which may occur in a pump installation. **(Modi, Sethi)**

50. What are the different efficiencies of a centrifugal pump? **(Modi, Sethi)**

51. What is meant by 'Priming' of a pump? What are the different priming arrangements employed for small and big pumping units? **(Modi, Sethi)**

52. The impeller of a centrifugal pump has 1.2 m outside diameter. It is used to lift 1800 litres of water per second against a head of 6m. Its vanes make an angle of 150° with the direction of motion at outlet and runs at 200 r.p.m. If the radial velocity of flow at outlet is 2.5 m/s, find the manometric efficiency. Also find the lowest speed to start the pump, if the diameter of the impeller at inlet is equal to half the diameter at exit. **(Modi, Sethi)**

Assignment Questions

UNIT-1

1. Define dynamic viscosity and kinematic viscosity. What are their units? Explain the significance of viscosity on fluid motion.
2. State Newton's equation of viscosity and give examples of its application.
3. An oil of viscosity 5 poise is used for lubrication between a shaft and sleeve. The diameter of shaft is 0.5 m and it rotates at 200 rpm. Calculate the horse power lost in the oil for a sleeve length of 100 mm. The thickness of the oil film is 1.0 mm.
4. The pressure at a point in a fluid is 13.6 cm of mercury vacuum. Express it in N/m2 of absolute pressure, gauge pressure and also in metres of water.
5. A 6 m deep tank is square in plan of size 2 m x 2 m. It contains water up to a depth of 4 m and oil of relative density 0.88 for the remaining height of 2 m. Determine the pressure on the bottom of the tank.
6. Carbon tetra chloride has a mass density of 1594 kg/m3. Calculate its mass density, specific weight and specific volume in the SI system of units. Also calculate its specific gravity.

7. 1.a) What is the difference between dynamic viscosity and kinematic viscosity? On what factors does the viscosity depend?

b) Two horizontal flat plates are placed 0.15 mm apart and the space between is filled with an oil of viscosity 1poise. The upper plate of area 1.5 m2 is required to move with a speed of 0.5 m/s relative to the lower plate. Determine the necessary force and power required to maintain this speed.**(2013)**

9. .Calculate the capillary effect in millimeters in a glass tube of 3 mm diameter, when immersed in (i) water and (ii) mercury. Both the liquids are at 200 C and the values of surface tensions for water and mercury at 200C in contact with air are 0.0736 N/m and 0.51 N/m respectively. The contact angle for water = 0o and for mercury = 1300.**(2013)**

10. a) A trapezoidal plate having its parallel sides equal to '2*a*' and '*a*' at a distance '*h*' apart is immersed vertically in a liquid with '2*a*' side uppermost and at a distance 'h' below the surface of the liquid. Find the thrust on the surface and the depth of the centre of pressure.

b) A rectangular door covering an opening 3m wide and 2 m high in a vertical wall be is hinged about its vertical edge by two pivots placed symmetrically 0.25 m from either end. The door is locked by a clamp placed at the centre of the vertical edge. Determine the reactions at the two hinges and the clamp, when the height of water is 1.5 m above the top edge of the opening.**(2013)**

UNIT-II

Two sharp ended pipes of diameters 50mm and 100mm respectively, each of length 100m are connected in parallel between two reservoirs which have a difference of level of 10m. If the friction factor 'f' is .005 calculate head loss due to friction.

i. A constant diameter pipe carrying constant discharge **(Nov 04)**

Obtain an expression for absolute pressure head at Vena-contracta for an external mouth-piece.

Find the velocity of an oil through a pipe, when the difference of mercury level in a differential U-tube manometer connected to the two tappings of the Pitot tube is 100 mm. Take coefficient of Pitot tube 0.98

4. What do you understand by total energy line, hydraulic gradient line, pies in series, pipes in parallel and equivalent pipe? **(Nov 02)**

5. a) Derive the continuity equation on Cartesian co-ordinates.

b) For a two dimensional flow, the velocity components are u = x/(x2+y2), v = y/(x2+y2).

Determine (i) the acceleration components ax and ay

(ii) the rotation ωz.

6.The angle of a reducing bend is 600 (that is deviation from initial direction to final direction). Its initial diameter is 300 mm and final diameter 150 mm and it is fitted in a pipe line, carrying a discharge of 360 liters/sec. The pressure at the commencement of the bend is 294.3 kN/m2. The friction loss in the pipe bend may be assumed as 10 percent of kinetic energy at exit of the bend. Determine the force exerted by the reducing bend**.** **(2013)**

7..a) Explain the characteristics of laminar and turbulent boundary layers.

b) Define the following terms

i) Laminar boundary layer

ii) Turbulent boundary layer**(2013)**

iii) Laminar sub layer

iv) Boundary layer thickness

UNIT -III

1 i. Explain firm power and secondary power in detail

ii. What are the different methods of classifying the hydroelectric power plants. Explain . **(Apr/May 09)**

2 i. What is a run off river plant. What are the different parts and arrangements of such plants? Draw a neat sketch and explain

ii. What is meant by flow duration curve and power duration curve. How do you differentiate these two curves? Also explain power duration curve in detail. **(Apr/May 09)**

3 i. Describe the status of hydroelectric power in India.

ii. Explain how the load factor, capacity factor and utilization factor interrelated. Also explain the significance of diversity factor. **(Apr/May 09)**

4 i. Explain firm power and secondary power in detail

ii. What are the different methods of classifying the hydroelectric power plants. **(Apr/May 09)**

5 i. Explain the inherent advantages, which make Hydropower more attractive.

ii. A runoff stream with an installed capacity of 12000KW operates at 15% load factor when it serves as a peak load station. What should be the lowest discharge in the stream so that the station may serve as the base load station. It is given that plant efficiency is 70% when working under a head of 18m. Also calculate maximum load factor of the plant when the discharge in the stream rises to 18 cumecs. **(Nov 08)**

6.a) Draw a neat sketch of the Reynolds apparatus, and explain how the laminar flow can be demonstrated with the help of the apparatus.
b) Derive an expression for the velocity distribution for turbulent flow in smooth pipes.**(2013)**

7.a) Prove that the work done per second per unit weight of water in a reaction turbine as 1/g (Vw1u1± Vw2u2)
b) Design a pelton wheel for a head of 80 m and speed 300 rpm. The pelton wheel develops 103 KW S.P. Take Cv = 0.98, speed ratio = 0.45 and overall efficiency = 0.80.**(2013)**

UNIT- IV

1. What do you mean by turbine? **(June 04)**
2. Differentiate between impulse and reaction turbines. Give examples. **(June 04)**
3. A model of a Francis turbine one-fifth of full size, develops 30.8 KW at 305 rpm, under a head of 2.5 m. Find the speed and power of full size turbine operating under a head of 6m. **(June 04)**
4. What is governing of turbine? Describe with a sketch the working of a system to regulate the speed of a Pelton turbine? **(June 04)**
5. A hydroelectric power station requires a turbine producing 3MW at 250 rpm under a head of 25m. Calcu-late the specific speed of the turbine. Estimate the runner diameter if the speed ratio is 0.70 and suggest the type of the turbine and runner.**(June 04)**
6. The pipes of diameter 'D' and 'd' of equal length 'L' are considered. If the pipes are arranged in parallel, the loss of head for either pipe for a flow of 'Q' is 'h'. If the pipes are arranged in series and the same quantity 'Q' flows through them, the loss of head is 'H'. If d = 0.5 D, find the percentage of total flow through each pipe when placed in parallel and the ratio of H to h neglecting minor losses and assuming friction co efficient to be constant.**(2013)**
7. a) Draw a neat sketch of the Reynolds apparatus, and explain how the laminar flow can be demonstrated with the help of the apparatus.
b) Derive an expression for the velocity distribution for turbulent flow in smooth pipes.**(2013)**

UNIT- V

1i. Define slip and coefficient of discharge of a reciprocating pump and write the expressions for the same. What do they practically indicate?
ii. The following details refer to working of a single acting reciprocating pump. Find the slip, coefficient of discharge and theoretical power required to drive the pump.
Piston diameter = 15 cm Crank radius = 15 cm Diameter of delivery pipe = 10 cm
Discharge of the pump = 0.31 m3 /min Total lift = 15 m
Speed of the pump = 60 rpm **(Feb 08, Nov 07)**

2. i. Derive the equation for work done by the impeller of a centrifugal pump on the fluid handled. What are different efficiencies of centrifugal pump ?
ii. Explain the working of a reciprocation pump with a neat sketch showing all the components. **(Feb 08)**

3 i. List all hydraulic losses, Mechanical losses and Leakage losses of a centrifugal pump. Explain when can centrifugal pumps arranged in series and in parallel.
ii. How can you find the power required to drive a reciprocating pump ? Define slip of a reciprocating pump. **(Feb 08)**
4 i. Discuss
b. Manometric efficiency b. Mechanical efficiency c. Volumetric efficiency

e. Overall efficiency and e. NPSH of a centrifugal pump.

ii. Explain how the number of pumps can be decided to be connected in series to deliver the water to a

5. .a) Find an expression for the discharge over a triangular notch in terms of head of water over the crest of the notch.

b) The following data relate to an orifice meter:

Diameter of the pipe = 240 mm
Diameter of the orifice = 120 mm
Specific gravity of oil = 0.88
Reading of differential manometer= 400 mm of mercury
Co efficient of discharge of the meter = 0.65
Determine the rate of flow oil**.(2013)**

6. a) Why are centrifugal pumps used some times in series and sometimes in parallel?

b) A centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is 300 of velocity of flow at outlet is 3 m/s. The pump is working against the total head of 30 m, and the discharge through the pump is 0.3 m3/s. If the manometric efficiency of the pump is 75%. Determine the diameter of the impeller and width of the impeller at outlet.(**2013)**