INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**HYDRAULICS AND HYDRAULIC MACHINERY**				
Course Code	ACE011				
Programme	B. Tech				
Semester	V	CE			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. Ch. V. S. S. Sudheer, Assistant Professor				
Course Faculty	Dr. P. Ram Mohan Rao, Professor & Head Mr. Ch. V. S. S. Sudheer, Assistant Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Strengthen the knowledge of theoretical and technological aspects of hydrodynamic forces on jets.
II	Correlate the principles with applications in hydraulic turbines.
III	Apply the practical applications on Francis and Kaplan turbine.
IV	Analysis the similarities between prototype and model types of hydraulic similitude.

COURSE OUTCOMES (COs):

CO 1	Describe the concept of different types of flows, designing of most economical sections of the Open Channel and to understand the concept of specific energy.
CO 2	Describe the concept of dimensional quantities and application of similitude concept in designing model and prototype.
CO 3	Understand the concept, working applications of impact of jets with the importance of constructing velocity triangles.
CO 4	Explore the design concept of Pelton, Francis and Kaplan turbines, Centrifugal pumps along with the design of most economical designs.
CO 5	Understand the working mechanism of different types of the pumps with their important characteristic curves.

COURSE LEARNING OUTCOMES (CLOs):

ACE011.01	Explain the concept for types of flows, type of channels, Non uniform flow - Dynamic equation for G.V.F., Mild, Critical, and Steep channels
ACE011.02	Understand concept of velocity distribution, energy and momentum correction factors for different flows.
ACE011.03	Understand Chezy's, Manning's and Basin formulae for uniform flow.
ACE011.04	Explain the concepts based on Specific energy, critical depth, critical, subcritical and super critical flows.
ACE011.05	Understand and designing for the computation of economical sections based on flow parameters and channel characteristics.
ACE011.06	Understand the Dimensional quantities and analysis for various parameters.
ACE011.07	Derive the problems based on Rayleigh's method and Buckingham's pi theorem with applications.
ACE011.08	Explain the concept of similitude with examples and different types of similitude concepts.
ACE011.09	Remember the concepts of dimensionless numbers to solve numerical problems
ACE011.10	Explain the practical problems associated with model and prototypes based on concept of similitude
ACE011.11	Explain the different types of jets used in construction of turbines and machinery and their importance.
ACE011.12	Demonstrate the formulation of velocity triangles at inlet and out let of vanes with different combinations of jet.
ACE011.13	Derive the expressions based on Angular momentum principle, work done and efficiency for various types of vanes.
ACE011.14	Explaining the concepts of hydro power plant with various components and their functioning.
ACE011.15	Deriving numerical problems based on power developed in Hydro power plant, efficiency of jet, stationary and moving vanes.
ACE011.16	Demonstrating different types of turbines with their principles and practical applications
ACE011.17	Remember the concept of work done, efficiency for different vanes and application to the concept of turbines.
ACE011.18	Deriving the expressions for most economical design of turbines to withstand for the designed discharge.
ACE011.19	Understand the working principles for various and working of different components of Kaplan, Francis and Pelton turbines.
ACE011.20	Understand the working mechanism of different types of pumps, importance and functioning of various components.
ACE011.21	Explain characteristic curves for pumps with their practical applications
ACE011.22	Understand the concept of NPSH, performance of pumps and working efficiency.
ACE011.23	Explain the designing of reciprocating pump and centrifugal pump.
ACE011.24	Understand the practical problems associated during the installation of pumps
ACE011.25	Understand the concept ANOVA to the real world Problems to measure the atmospheric tides.

TUTORIAL QUESTION BANK

	UNIT- I			
OPEN CHANNEL FLOW				
Part - A (Short Answer Questions)				
S No	**QUESTIONS**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course Learning Outcomes (CLOs)**
1	Explain about the flow in open channel with a neat sketch.	Understand	CO 1	ACE011.01
2	Differentiate between critical, sub critical and super critical flow in open Channel.	Understand	CO 1	ACE011.02
3	Explain the term Rapidly Varying Flow (RVF) with a neat sketch in open channels.	Remember	CO 1	ACE011.02
4	Explain the term Gradually Varying Flow (GVF) with a neat sketch in open channels.	Remember	CO 1	ACE011.02
5	What do you mean by economical section of a channel? Explain the conditions applied.	Understand	CO 1	ACE011.02
6	Explain the terms specific energy of a flowing liquid in an open channels	Remember	CO 1	ACE011.02
7	Explain different types of channels based on depth of flow.	Remember	CO 1	ACE011.01
8	Explain the term critical depth and mention the importance of it.	Remember	CO 1	ACE011.01
9	Explain the term critical velocity and mention the importance of it.	Remember	CO 1	ACE011.01
10	Explain the term hydraulic jump in an open channel with a neat sketch.	Remember	CO 1	ACE011.01
11	Define back water curve and explain how does it forms in a channel.	Remember	CO 1	ACE011.02
12	Explain the differences between channel and rivers.	Remember	CO 1	ACE011.05
13	Explain the term mild slope, critical slopes, steep slopes, horizontal slopes and adverse slopes.	Remember	CO 1	ACE011.05
14	Explain the velocity distribution diagram of an open channel and write the condition for maximum velocity.	Remember	CO 1	ACE011.05
15	Explain with a neat sketch the velocity distributions of rectangular, trapezoidal channels.	Remember	CO 1	ACE011.05
16	Write the equation for chezy"s equation and explain all the terms involved in it.	Remember	CO 1	ACE011.05
17	Define energy dissipation?	Remember	CO 1	ACE011.01
18	What do you understand by Manning"s formula? How do you apply for channels?	Remember	CO 1	ACE011.02
19	Discuss Bazin"s formula for uniformflow and explain the relation between chezy's and Bazin's formula.	Remember	CO 1	ACE011.03
20	Define steady flow uniform flow, unsteady flow and non-uniform flow in open channels.	Remember	CO 1	ACE011.03
Part - B (Long Answer Questions)				
1	Derive an expression for the discharge through a channel by Chezy"s formula.	Understand	CO 1	ACE011.03
2	Derive the conditions for most economical section of a rectangular channel	Understand	CO 1	ACE011.02
3	Derive the conditions for the best side slope of the most economical Trapezoidal section	Remember	CO 1	ACE011.02
4	Prove that for a channel of circular section, the depth of flow, d=0.81D, for maximum velocity, and=0.95D for maximum discharge, D=diameter of a circular channel, d= depth of flow.	Understand	CO 1	ACE011.03
5	Derive an expression for critical depth and critical velocity.	Remember	CO 1	ACE011.02
6	Derive the condition for maximum discharge for a given value of specific energy	Remember	CO 1	ACE011.02
7	Derive an expression for the depth of hydraulic jump in terms of upstream Froude number.	Understand	CO 1	ACE011.02

8	Derive the momentum equation, for an open channel flow, State the assumptions made in the derivations.	Remember	CO 1	ACE011.02
9	Derive the differential equation for steady gradually varied flow open Channels and list all assumptions?	Understand	CO 1	ACE011.02
10	Prove that the loss of energy head in a hydraulic jump is equal to where d1and d2 are the conjugate depths.	Remember	CO 1	ACE011.02
11	Find velocity, rate of flow through a rectangular channel of 6mts wide and 3mts deep, when it is running full. The channel is having a bed slope as1 in 2000.Take Chezy's Constant C=55.	Remember	CO 1	ACE011.02
12	Find the discharge of water through a trapezoidal channel of width 8mts and side slope as 1 Horizontal to 3 Vertical. The depth of flow of water is 2.4 mts and value of Chezy's Constant=50.The slope of the bed of the channel is given 1 in 4000.	Remember	CO 1	ACE011.02
13	Find the discharge through a rectangular channel of width 2mts, having a bed slope of 4 in 8000.The depth of flow is 1.5mts and take the value of N in Manning's formula as 0.012.	Remember	CO 1	ACE011.03
14	Find the discharge through a rectangular channel 2.5mts wide, having depth of water 1.5mts and bed e2saslope as 1 in 2000.Take the value of k =2.36mts in Bazin's formula.	Remember	CO 1	ACE011.02
15	Find the diameter of a circular sewer pipe which is laid at aslope of 1 in8000and carries a discharge of 800 liters/sec when flowing half full. Take the value of Manning's N=0.020.	Remember	CO 1	ACE011.03
16	A rectangular channel 4mts wide has a depth of water 1.5mts.The slope of the bed of the channel is 1 in 1000 and value of Chezy's constant C=55It is desired to increase the discharge to a maximum by changing the dimensions of the section for constant area of cross-section, slope of the bed and roughness of the channel .Find the new dimensions of the channel and increase in discharge.	Remember	CO 1	ACE011.02
17	A trapezoidal channel has slopes of 1 horizontal to 2 vertical and the slope of the bed is 1 in 1500.The area of the section is 40m2.Find the dimensions of the section if it is most economical. Determine the discharge of the most economical section if C=50.	Remember	CO 1	ACE011.02
18	Find the discharge through a circular pipe of diameter of 3mts,if the depth of the water pipe is 1mt and the pipe is lid at a slope of 1 in 1000.Take the value of Chezy"s constant as 70	Understand	CO 1	ACE011.03
19	The discharge of water through a rectangular channel of width 8mts is15m3/sec When the depth of flow of water is 1.2mts.Calculate specific energy of the Flowing water; critical depth and critical velocity; value of minimum specific Energy.	Understand	CO 1	ACE011.04
20	The depth of flow of water at certain section of a rectangular channel of 4 mts Width is 0.5mts.The discharge through the channel is 16 m^3/sec. If a hydraulic Jump takes place on downstream side. Find the depth of flow after the jump.	Remember	CO 1	ACE011.04
Part - C (Problem Solving and Critical Thinking Questions)				
1	A trapezoidal irrigation canal is to be excavated in soil and lined with coarse gravel. The canal is to be designed for a discharge of 200 cfs, and it will have slope of 0.0016. What should be the magnitude of the cross-sectional area and hydraulic radius for the canal if it is to be designed so that erosion of the canal will not occur? Choose a canal cross section that will satisfy the limitations.	Understand	CO 1	ACE011.01
2	A 10-ft wide rectangular channel is very smooth except for a small reach that is roughened with angle irons attached to the bottom of the channel. Water flows in the channel at a rate of 200 cfs and at a depth of 1.00 ft. Assume frictionless flow except over the roughened part where the total drag of all the roughness (all the angle irons) is assumed to be 2000 lb. Determine the depth at the end of the roughness elements for the assumed conditions.	Understand	CO 1	ACE011.01

3	Determine diameter D of a circular conduit in such a way that discharge Q = 6,5 m^3 / s will flow through it with a free water level. Values of diameters of produced profiles vary after 200 mm. Longitudinal slope of conduit i_0 = 0,003, roughness coefficient n = 0,011. Determine the maximum depth Y_o and velocity of flow V. What longitudinal slope i_0 [‰] should have the conduit in order to the indicated discharge was the maximum one in conduit.	Understand	CO 1	ACE011.02
4	Discharge Q = 12 m^3 / s flows through rectangular channel. Width of the channel is b = 3,0 m. Calculate and draw in graph a dependency of energy head (specific energy) of cross section on channel depth Ed = f(y). Find out the value of critical depth. Determine kind of flow in the channel for two depths: 0,6 m and 2.4 m.	Remember	CO 1	ACE011.03
5	Find the discharge through a circular pipe of diameter of 5mts,if the depth of the water pipe is 2mt and the pipe is lid at a slope of 1 in 1100.Take the value of Chezy"s constant as 70.	Understand	CO 1	ACE011.03
6	A rectangular channel 3mts wide has a depth of water 1.6mts.The slope of the bed of the channel is 1 in 1200 and value of Chezy's constant C=50 It is desired to increase the discharge to a maximum by changing the dimensions of the section for constant area of cross-section, slope of the bed and roughness of the channel .Find the new dimensions of the Channel and increase in discharge.	Remember	CO 1	ACE011.02
7	Find the discharge of water through a trapezoidal channel of width 9mts and side slope as 1 Horizontal to 3 Vertical. The depth of flow of water is 2.5mts and value of Chezy's Constant=55.The slope of the bed of the channel is given 1 in 4000.	Remember	CO 1	ACE011.02
8	The discharge of water through a rectangular channel of width 10mts is 25m3/sec When the depth of flow of water is 1.5mts.Calculate specific energy of the Flowing water; critical depth and critical velocity; value of minimum specific Energy.	Understand	CO 1	ACE011.04
9	Find the discharge through a rectangular channel of width 2.5mts, having a bed slope of 4 in 8000.The depth of flow is 1.8mts and take the value of N in Manning's formula as 0.011.	Remember	CO 1	ACE011.02
10	Find velocity, rate of flow through a rectangular channel of 5mts wide and 3.5mts deep, when it is running full. The channel is having a bed slope as 1 in 2500.Take Chezy's Constant C=50.	Remember	CO 1	ACE011.02
	UNIT-II			
	DIMENSIONAL ANALYSIS AND SIMILITUDE			
	Part – A (Short Answer Questions)			
1	Define the term dimensional analysis and model analysis.	Remember	CO 2	ACE011.06
2	Discuss the difference between model and prototype with examples	Remember	CO 2	ACE011.07
3	Discuss fundamental and derived units. Give examples.	Understand	CO 2	ACE011.06
4	Explain the term “dimensionally homogeneous equation”.	Understand	CO 2	ACE011.07
5	Enumerate the method of analysis for dimensional quantities.	Understand	CO 2	ACE011.06
6	Define repeating variables with examples.	Remember	CO 2	ACE011.07
7	State Rayleigh"s theorem.	Understand	CO 2	ACE011.06
8	Explain the term of Geometric similarity with formula.	Understand	CO 2	ACE011.07
9	Explain the term of Kinematic similarity with formula.	Understand	CO 2	ACE011.08
10	Explain the term of Dynamic similarity with formula.	Understand	CO 2	ACE011.06
11	Explain the term Distorted and Undistorted model.	Remember	CO 2	ACE011.06
12	State Buckingham"s π –theorem. With neat sketch.	Remember	CO 2	ACE011.07
13	Write the dimensional forms of velocity, acceleration, mass and ressure.	Remember	CO 2	ACE011.07
14	Write the dimensional forms of kinematic viscosity and dynamic viscosity.	Remember	CO 2	ACE011.08
15	Define Reynolds"s number, Weber number and Mach number in view of dimensional numbers	Remember	CO 2	ACE011.08

16	Define Froud"s number and Mach numbers in view of dimensional numbers.	Remember	CO 2	ACE011.07
17	Explain the steps for writing the dimensional number.	Remember	CO 2	ACE011.06
18	Mention the advantages and disadvantages of dimensional numbers.	Understand	CO 2	ACE011.08
19	What is length ratio, scale ratio and area ratio for dimensional quantities?	Understand	CO 2	ACE011.07
20	Mention the assumptions made in Buckingham"s π –theorem.	Understand	CO 2	ACE011.07
	Part - B (Long Answer Questions)			
1	Describe the Rayleigh"s method for dimensional analysis.	Understand	CO 2	ACE011.07
2	Explain the different types of hydraulic similarities that must exist between a proto type and it"s model?	Remember	CO 2	ACE011.08
3	Explain the different laws on which models are designed for dynamic	Remember	CO 2	ACE011.08
4	Prove that ratio of inertia force to viscous force gives the Reynold's number?	Understand	CO 2	ACE011.08
5	Enumerate significance of the non-dimensional numbers: Reynold's number, Froude number and mach number in the theory of similarity? What is dimensional analysis? How is this analysis related to the theory of similarity?	Remember	CO 2	ACE011.07
6	Explain the process of model testing of partially sub–merged bodies?	Remember	CO 2	ACE011.07
7	Explain about the scale ratios for distorted models.	Understand	CO 2	ACE011.08
8	Determine the dimensions of the quantities given below : i. angular velocity ii. angular acceleration iii. discharge iv. kinematic viscosity v. force vi. Specific weight.	Understand	CO 2	ACE011.06
9	Discuss the method of selecting repeating variables.	Remember	CO 2	ACE011.07
10	Explain the procedure for solving problems by Buckingham„s π theorem.	Understand	CO 2	ACE011.07
11	Determine the dimensions of the given quantities; Discharge, Force, Specific Weight, angular acceleration, dynamic viscosity, kinematic viscosity.	Remember	CO 2	ACE011.10
12	The time period of a pendulum depends upon the length of the pendulum, Acceleration due to gravity. Determine expression for time period using Rayleigh"s method.	Understand	CO 2	ACE011.08
13	Find an expression for the drag force on smooth sphere of diameter "D" with Uniform velocity "V" in a fluid of density and dynamic viscosity.	Remember	CO 2	ACE011.07
14	Efficiency of a fan depends upon density; dynamic viscosity; angular velocity; Diameter; discharge. Express efficiency in dimension less parameters. using Rayleigh"s method.	Understand	CO 2	ACE011.07
15	Efficiency depends upon density, dynamic viscosity; angular velocity; Diameter discharge. Express in terms of dimensionless parameters using Buckingham"s Theorem.	Understand	CO 2	ACE011.06
16	The pressure difference in a pipe of diameter „D" and length „L" due to turbulent Flow depends upon velocity ;viscosity ;density; roughness using Bunkhingam"s Theorem obtain expression for pressure difference.	Remember	CO 2	ACE011.07
17	A pipe of diameter 1.5mts is required to transport an oil of specific gravity 0.90 and viscosity 3X10-2 poise at a rate of 3000 litres/sec .Tests were conducted on15cm diameter pipe using water at 200c.Find the velocity and rate of flow in the Model. Viscosity of water at 200c is 0.01 poise.	Understand	CO 2	ACE011.07
18	Water is flowing thro ugh a pipe of diameter 30cm pipe at velocity of 4m/sec. Find the velocity of oil flowing in another pipe of diameter 10cm.If the condition Of dynamic similarity is satisfied between the two pipes .The viscosity of water and oil is given as 0.01poise and 0.025 poise. Specific gravity of oil is 0.8.	Remember	CO 2	ACE011.08
19	The ratio of lengths of a submarine and its model is 30:1.The speed of Submarine is 10m/sec. The model is to be tested in a wind tunnel. Find the	Understand	CO 2	ACE011.08

	speed Of air in wind tunnel. Also determine the ratio of drag (resistance) between the Model and its prototype. Take the value of kinematic viscosities for sea water And air is given as 1030 kg/m3 and 1.24 kg/m3 respectively.			
20	A ship 300 m long moves in a sea water whose density is 1030kg/m3.1:100 Ratio of model is to be tested in a wind tunnel .The velocity of air in the wind Tunnel around the model is 30m/sec and resistance of the model is 60N. Determine the velocity of ship in sea water and also the resistance of ship in sea Water .The density of air is 1.24kg/m3.Kinematic viscosity of sea water and air Are 0.012 stokes and 0.018 stokes respectively.	Understand	CO 2	ACE011.08
	Part - C (Problem Solving and Critical Thinking Questions)			
1	A pipe of diameter 1.8mts is required to transport an oil of specific gravity 0.92 and viscosity 3.1X10 $^{-2}$ poise at a rate of 3050 litres/sec. Tests were conducted on14 cm diameter pipe using water at 20^{0} C. Find the velocity and rate of flow in the Model. Viscosity of water at 20^{0} C is 0.01 poise.	Understand	CO 2	ACE011.07
2	The ratio of lengths of a submarine and its model is 25:1.The speed of Submarine is 18m/sec. The model is to be tested in a wind tunnel .Find the speed Of air in wind tunnel. Also determine the ratio of drag (resistance) between the Model and its prototype. Take the value of kinematic viscosities for sea water And air is given as 1030 kg/m^{3} and 1.24kg /m^{3} respectively.	Understand	CO 2	ACE011.08
3	Explain in detail about derivation of Buckingham pi theorem.	Remember	CO 2	ACE011.07
4	Determine the dimensions of the quantities given below : i) Angular velocity ii) Angular momentum iii) Discharge iv) Kinematic viscosity v) Force vi) Specific weight vii) Dynamic similarities formula viii) Geometric similarities formula.	Remember	CO 2	ACE011.06
5	A ship 500 m long moves in a sea water whose density is 1030 kg/m^{3}. 1:100 Ratio of model is to be tested in a wind tunnel .The velocity of air in the wind Tunnel around the model is 25m/sec and resistance of the model is 80N. Determine the velocity of ship in sea water and also the resistance of ship in sea Water .The density of air is 1.24kg/m^{3}. Kinematic viscosity of seawater and air Are 0.010 stokes and 0.015 stokes respectively.	Understand	CO 2	ACE011.08
6	Explain the process of model testing of partially merged & sub–merged bodies?	Remember	CO 2	ACE011.06
7	Derive an expression for the drag force on smooth sphere of diameter “D” with Uniform velocity “V” in a fluid of density and dynamic viscosity.	Understand	CO 2	ACE011.07
8	Discuss the method of selecting repeating variables.	Remember	CO 2	ACE011.07
9	Water is flowing through a pipe of diameter 50cm pipe at velocity of 5 m/sec. Find the velocity of oil flowing in another pipe of diameter 13cm. If the condition Of dynamic similarity is satisfied between the two pipes .The viscosity of water and oil is given as 0.01poise and 0.025 poise. Specific gravity of oil is 0.81.	Remember	CO 2	ACE011.08
10	Describe the Rayleigh”s method for dimensional analysis& with example.	Understand	CO 2	ACE011.09
	UNIT -III			
	HYDRODYNAMIC FORCE ON JETS			
	Part - A (Short Answer Questions)			
1	Define the term impact of jets with neat sketch?	Understand	CO 3	ACE011.11
2	Obtain an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of jet.	Understand	CO 3	ACE011.12

3	Water is flowing through a pipe at the end of which a nozzle is fitted .the diameter of the nozzle 100mm and the head of water at the centre of nozzle is 100 m .find the force exerted by the jet of water on a fixed vertical plate the coefficient of velocity is given as 0.95.	Remember	CO 3	ACE011.12
4	A jet of water of diameter 50mm moving with a velocity of 40 m/s, strikes a curved fixed symmetrical plate at the centre. Find the force excreted by the jet of water in the direction the jet, if the jet is deflected through an angle of 120^0 at the out let of the plate.	Remember	CO 3	ACE011.12
5	Obtain an expression for the force excreted by a jet of water on a flat vertical plate moving in the direction of jet	Understand	CO 3	ACE011.12
6	Describe the procedure to draw inlet and out let triangles.	Remember	CO 3	ACE011.12
7	Write the equation for the force exerted by a jet of water on a fixed vertical plate.	Understand	CO 3	ACE011.12
8	Write the equation for the force exerted by a jet of water on a moving	Understand	CO 3	ACE011.12
9	Write the equation for the force exerted by a jet of water on a fixed inclined plate.	Understand	CO 3	ACE011.12
10	Write the equation for the force exerted by a jet of plate in the direction normal to the fixed inclined pate	Remember	CO 3	ACE011.12
11	Write the equation for the force exerted by a jet of water on a moving inclined plate.	Understand	CO 3	ACE011.13
12	Write the equation for the force exerted by a jet of water on a fixed curved plate at center .	Understand	CO 3	ACE011.13
13	Write the equation for the force exerted by a jet of water on a fixed curved plate at one end tangentially when the plate is symmetrical.	Understand	CO 3	ACE011.13
14	Write the equation for the force exerted by a jet of water on a fixed curved plate at one end tangentially when the plate is unsymmetrical.	Understand	CO 3	ACE011.13
15	Write the equation for the force exerted by a jet of water on a moving curved plate at center.	Remember	CO 3	ACE011.13
16	Write the equation for the force exerted by a jet of water on the moving plate in the direction normal to the inclined plate.	Understand	CO 3	ACE011.13
17	A jet of water of diameter 50 mm moving with a velocity of 25 m /s impinges on a fixed curved plate tangentially at one end at an angle of 30^0 to the horizontal. Calculate the resultant force of the jet on the plate if the jet is deflected through an angle of 50^0. Take g = 10 m / s^2.	Remember	CO 3	ACE011.12
18	A jet of water of diameter 75 mm moving with a velocity of 25m/s strikes a fixed plate in such a way that the angle between the jet &plate is 60^0. Find the force exerted by the jet on the plate in the direction normal to the plate .	Remember	CO 3	ACE011.12
19	Explain the force exerted by a jet on stationary inclined flat plate?	Remember	CO 3	ACE011.12
20	A jet of water of diameter 75 mm moving with a velocity of 30 m/s strikes a fixed plate in such a way that the angle between the jet and plate is 60^0. Find the force exerted by the jet on the plate in the direction of the jet .	Remember	CO 3	ACE011.12
	Part – B (Long Answer Questions)			
1	Explain the force on the inclined plate moving in the direction of the jet	Remember	CO 3	ACE011.12
2	Explain the force on the curved plate when the plate is moving in the direction of jet.	Remember	CO 3	ACE011.12
3	Explain the force exerted by a jet of water on an un symmetrical moving curved plate when jet strikes tangentially at one of the tips ?	Understand	CO 3	ACE011.12
4	Explain the force exerted on a series of radial curved vanes?	Understand	CO 3	ACE011.12
5	A jet of water strikes with a velocity of 35 m/s, a flat plate inclined at 30^0 with the axis of the jet. If the cross sectional area of the jet is $25cm^2$, determine: a) The force exerted by the jet on the plate. b). The components of the force in the direction of normal jet. c). The ratio in which the discharge gets divided after striking the plate.	Understand	CO 3	ACE011.12

6	A rectangular plate, weighing 60 N is suspended vertically by a hinge on the top horizontal edge. The centre of gravity of the plate is 100 mm from the hinge. A horizontal of water 20 mm diameter, whose axis is 150 mm below the hinge impinges normally on the plate with a velocity of 5 m/s. Determine: a). The horizontal force applied on the centre of gravity to maintain the plate in its vertical direction. b). The corresponding velocity of the jet, if the plate is deflected through 30^0 and the same force continue to act at the centre of gravity of the plate.	Understand	CO 3	ACE011.13
7	A nozzle of 50 mm diameter delivers a stream of water at 20 m/s perpendicular to a plate that moves away from the jet at 5 m/s. Find: a) The force on the Plate b) The work done and c) The efficiency of jet.	Understand	CO 3	
8	Prove that for a curved radial vane the efficiency is given by: $\eta = \frac{2(v_{w1}\, u_1 \pm v_{w2}\, u_2)}{v_1^2}$	Understand	CO 3	ACE011.12
9	In a jet propelled boat water is drawn a mid-ship and discharged at the back with an absolute velocity of 20 m/s. If the cross - sectional area of the jet is 200 cm^2 and the boat is moving in sea water with a speed of 8.33 m/s determine: i. The propelling force on the boat. ii. Power required to drive the pump and iii. Efficiency of jet propulsion.	Understand	CO 3	ACE011.13
10	Write the components of hydro power plants and explain them in detail.	Remember	CO 3	ACE011.13
11	What are the steps involved in calculating the hydro power with the units?	Remember	CO 3	ACE011.13
12	Define head and explain different types of head?	Remember	CO 3	ACE011.13
13	Explain in detail different types of efficiencies and write them with formula of each.	Remember	CO 3	ACE011.13
14	Mention the components of hydropower plant and explain in detail the working of each component.	Remember	CO 3	ACE011.14
15	The following data relate to a proposed hydro – electric station: Available head = 28 m, catchment area = 420 Sq. Km. Rainfall = 140 cm /year, percentage of total rainfall utilized = 68 %, Penstock efficiency = 94 %, Turbine efficiency = 80 %, Generator efficiency = 84 % and load factor = 44 %. Determine the following: a. The power developed by turbine. b. Suggest suitable machines corresponding to the given data and specify the same.	Understand	CO 3	ACE011.13
16	In a Hydroelectric power plant, the available discharge and head are 330 m^3/s and 28 m respectively. The turbine efficiency is 86 %. The generator is directly coupled to the turbine. The frequency of generator is 50 Hz and number of poles used are 24. Find the least number of machines required if, a. A Francis turbine with a specific speed of 260 is used. b. A Kaplan turbine with a specific speed of 700 is used.	Understand	CO 3	ACE011.13
17	At a particular site the mean discharge in millions of m^3 of a river is 12 months from January to December are given below: 80, 50,40,0,20,0,100,150, 200,220, 120,100 and 80 respectively. Determine the power in MW available at mean flow if the head available is 100 m and overall efficiency of generation is 80 %.	Understand	CO 3	ACE011.13

18	In a hydro electric power plant the reservoir is 225 m above the turbine house. The annual replenishment of reservoir is 3.5 X 10^{12} N. Calculate the energy available at the generating station bus bars, if the loss of the head in the hydraulic system is 225 m and the overall efficiency of the system is 85 %. Determine the diameter of two steel penstocks, if maximum demand of 45 MW is to be supplied.	Understand	CO 3	ACE011.13
19	Compare the differences between hydro power station with thermal power station.	Remember	CO 3	ACE011.13
20	Calculate the firm capacity of a run-of-river hydro power plant to be based on 8 hours peak plant assuming daily flow in a river to be constant at 15 m^3/s. Also calculate Pondage factor and Pondage if the head of the plant is 11 m and overall efficiency is 85%.	Understand	CO 3	ACE011.14
	Part – C (Problem Solving and Critical Thinking)			
1	Explain the force on the curved plate when the plate is moving in the direction of jet.	Remember	CO 3	ACE011.14
2	A nozzle of 80 mm diameter delivers a stream of water at 25 m/s perpendicular to a plate that moves away from the jet at 8 m/s. Find: a) The force on the plate. b) The work done and c) The efficiency of jet.	Understand	CO 3	ACE011.12
3	Define the term impact of jets & explain in details of stationary & movable jets with neat sketch	Remember	CO 3	ACE011.13
4	Water is flowing through a pipe at the end of which a nozzle is fitted .the diameter of the nozzle 120mm and the head of water at the centre of nozzle is 120 m .find the force exerted by the jet of water on a fixed vertical plate the coefficient of velocity is given as 0.98.	Understand	CO 3	ACE011.13
5	Explain the force exerted on a series of radial curved vanes?	Remember	CO 3	ACE011.14
6	At a particular site the mean discharge in millions of m^3 of a river is 12 months from January to December are given below: 80, 55,45,0,25,0,110,145, 180,210, 110, 90 and 85 espectively. Determine the power in MW available at mean flow if the head available is 120 m and overall efficiency of generation is 85 %.	Understand	CO 3	ACE011.13
7	In a hydro electric power plant the reservoir is 240 m above the turbine house. The annual replenishment of reservoir is 4.2 X 10^{12}N. Calculate the energy available at the generating station bus bars, if the loss of the head in the hydraulic system is 245 m and the overall efficiency of the system is 80 %. Determine the diameter of two steel penstocks, if maximum demand of 50 MW is to be supplied.	Understand	CO 3	ACE011.13
8	Calculate the firm capacity of a run-of-river hydro power plant to be based on 8 hours peak plant assuming daily flow in a river to be constant at 18 m^3/s. Also calculate Pondage factor and Pondage if the head of the plant is 11 m and overall efficiency is 80%.	Remember	CO 3	ACE011.13
9	Define head and explain different types of head & with neat sketch.	Remember	CO 3	ACE011.12
10	The following data relate to a proposed hydro – electric station: Available head = 30 m, catchment area = 450 Sq. Km. Rainfall = 110 cm /year, percentage of total rainfall utilized = 68 %, Penstock efficiency = 94 %, Turbine efficiency = 90 %, generator efficiency = 85 % and load factor = 45 %. Determine the following 1. The power developed by turbine. 2. Suggest suitable machines corresponding to the given data and specify the same.	Understand	CO 3	ACE011.14
	UNIT -IV			
	HYDRAULIC TURBINES			
	Part – A (Short Answer Questions)			
1	Define turbine and different types of turbine with neat sketch?	Remember	CO 4	ACE011.16

2	Discuss about following efficiencies: i) hydraulic efficiency ii) mechanical efficiency iii) volumetric efficiency iv) overall efficiency.	Understand	CO 4	ACE011.17
3	Write short notes on classification of hydraulic turbines.	Understand	CO 4	ACE011.16
4	Discuss about various parts of pelton wheel.	Remember	CO 4	ACE011.17
5	Discuss about various parts of radial flow reaction turbines.	Understand	CO 4	ACE011.16
6	What are governing of turbines?	Remember	CO 4	ACE011.17
7	Define surge tanks With neat sketch .	Remember	CO 4	ACE011.16
8	Define the following: i) unit speed ii) unit power iii)unit discharge.	Understand	CO 4	ACE011.16
9	Discuss about specific speed performance of turbine.	Remember	CO 4	ACE011.16
10	Explain about cavitation in turbines.	Remember	CO 4	ACE011.16
11	Derive an expression for hydraulic efficiency of a Pelton wheel.	Understand	CO 4	ACE011.17
12	What is the condition for hydraulic efficiency of a Pelton wheel to be maximum?	Understand	CO 4	ACE011.16
13	Where Kaplan turbine is is used, with neat sketch?	Understand	CO 4	ACE011.16
14	On what factors does the cavitation in water turbine depend.	Understand	CO 4	ACE011.17
15	State the advantages of a Kaplan turbine over Francis Turbine.	Understand	CO 4	ACE011.16
16	Define the specific speed of turbine with neat sketch?	Remember	CO 4	ACE011.16
17	Enumerate some methods to avoid cavitation in turbines.	Remember	CO 4	ACE011.17
18	State the condition for hydraulic efficiency of a Pelton wheel to be maximum.	Remember	CO 4	ACE011.16
19	Mention the points to be considered while selecting right type of hydraulic turbines for hydroelectric power plant.	Remember	CO 4	ACE011.16
20	What is surge tank with neat sketch?	Remember	CO 4	ACE011.17
	Part – B (Long Answer Questions)			
1	Define a draft tube? What are its functions?	Understand	CO 4	ACE011.16
2	Differentiate between an inward and out ward flow reaction turbine?	Remember	CO 4	ACE011.17
3	Define cavitation? How can it be avoided in reaction turbine ?	Remember	CO 4	ACE011.16
4	Understanding by characteristic curves of a turbine? Name the important curves and their significance.	Remember	CO 4	ACE011.16
5	Define the term governing of turbines? Describe with a neat sketch the working mechanisam of Pelton wheel.	Remember	CO 4	ACE011.17
6	A Pelton turbine develops 3000 Kw under a head of 300 m. The overall efficiency of the turbine is 83 % . If speed ratio = 0.46 , c_V=0.98 and specific speed is 16.5 , then find : i) Diameter of the turbine and ii) diameter of the jet.	Remember	CO 4	ACE011.16
7	A turbine develops 9000 kW when running at a speed of 140 r. p m and under a head of 30 m .Determine the specific speed of the turbine.	Understand	CO 4	ACE011.16
8	Derive an expression for specific speed of a turbine.	Remember	CO 4	ACE011.17
9	A water turbine has a velocity of 6 m/s at the entrance to the draft tube and a velocity of 1.2 m/s at the exit. For friction losses of 0.1 m and a tail water 5m below the entrance to the draft tube, find the pressure head at the entrance.	Remember	CO 4	ACE011.16
10	A turbine is to operate under a head of 25 m at 200 r. p .m. The discharge is 9 cumsec. Determine i. Specific speed of turbine ii. Power generated iii. Type of machine	Understand	CO 4	ACE011.16
11	A Pelton wheel has a mean bucket speed of 100m/sec with a jet of water at the Rate of 70 litres /sec under a head of 30mts.The buckets deflect the jet through an angle of 1600. Calculate the power given by water to the runner and the Hydraulic efficiency of the turbine. Assume coefficient of velocity as 0.98.	Understand	CO 4	ACE011.17

12	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, i) Discharge through the runner. ii) width at outlet if width at inlet =200 mm .	Remember	CO 4	ACE011.16
13	A reaction turbine works at 500 r.p.m under a head of 100 m. the diameter of turbine at inlet is 100 cm and flow area is 0.35 m^2.The angles made by absolute and relative velocities at inlet are 15^0 and 60^0 respectively with the tangential velocity , determine i. The volume rate of flow. ii. The power developed. iii. Efficiency, assume whirl at outlet to be zero.	Remember	CO 4	ACE011.16
14	An outward flow reaction turbine has internal and external diameters of the runner as 0.5 m and 1.0 m respectively. The guide blade angle is 15^0 and velocity of flow through the runner is constant and equal to 3 m/s. If the speed of the turbine is 250 r.p.m and head on turbine is 10 cm and discharge at out let is radial. Determine: i. Runner vane angles at inlet and out let. ii. Work done by the water on the runner per sec per unit weight of water striking per sec and iii. Hydraulic efficiency.	Understand	CO 4	ACE011.17
15	A Pelton wheel 3.75 m/s and radial velocity of flow at inlet is 12.02 m/s The wheel runs at200 r.p.m and hydraulic losses in the turbine are 20 % of the available energy assume radial discharge, determine: i) The guide blade angle ii) The wheel vane angle at inlet , iii) Dia of wheel at inlet iv) Width of wheel at inlet	Understand.	CO 4	ACE011.16
16	A Kaplan turbine working under a head of 15 m develops 7357.5Kw shaft power .The outer diameter of runner is 4 m and hub diameter is 2 m .The guide blade angle at the extreme edge of the runner is 30^0.The hydraulic and over all efficiencies of the turbine are 90% and 85% respectively. Tthe velocity of whirl is zero at outlet , determine : i) runner vane angles at inlet and out let, ii) speed of the turbine.	Understand	CO 4	ACE011.17
17	A conical draft tube having inlet and out let diameters 0.8m and 1.2 m discharges water at outlet with a velocity of 3 m/s .The total length of draft tube is 8 m and 2m of the length of draft tube is immersed in water .If the atmospheric pressure head 10.3 m of water and loss of head due to friction in the draft tube is equal to 0.25 times the velocity head at out let of the tube ,find i. Pressure head at inlet and ii. Efficiency of draft tube.	Understand	CO 4	ACE011.16
18	A turbine is to operate under a head of 30 m at 300 r.p.m, the discharge is 10 m^3/s . if the efficiency is 90 % , determine i) Specific speed of the machine ii) Power generated. iii) type of the turbine.	Remember	CO 4	ACE011.17
19	A turbine develops 7357.5 Kw shaft power when running at 200 r.p.m. the head on the turbine is 40 m. If the head on the turbine is reduced to25 m, determine the speed and power developed by the turbine.	Remember	CO 4	ACE011.16
20	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 the nozzle is 150 liters /sec. find i) power available at the nozzle , ii) Hydraulic efficiency of the turbine.	Remember	CO 4	ACE011.17

Part – C (Problem Solving and Critical Thinking)				
1	Derive an expression for specific speed of a turbine with example.	Remember	CO 4	ACE011.17
2	A Pelton turbine develops 3250 Kw under a head of 350 m . The over-all efficiency of the turbine is 85 % . If speed ratio = 0.46 , c_V=0.98 and specific speed is 16.5 , then find : i) diameter of the turbine and ii) diameter of the jet.	Understand	CO 4	ACE011.16
3	An inward flow reaction turbine has external and internal diameters as 1.3 m and 0.7 m respectively. The velocity of flow through the runner is constant and is equal to 1.75 m/s. Determine i) Discharge through the runner , ii) Width at outlet if width at inlet =210 mm .	Remember	CO 4	ACE011.16
4	A Pelton wheel has a mean bucket speed of 120m/sec with a jet of water at the Rate of 85 litres/sec under a head of 30mts.The buckets deflect the jet through an angle of 1650. Calculate the power given by water to the runner and the Hydraulic efficiency of the turbine. Assume coefficient of velocity as 1.0.	Remember	CO 4	ACE011.17
5	A water turbine has a velocity of 6 m/s at the entrance to the draft tube and avelocity of 1.5 m/s at the exit. For friction losses of 0.12 m and a tail water 6 m below the entrance to the draft tube , find the pressure head at the entrance.	Remember	CO 4	ACE011.16
6	A turbine is to operate under a head of 35 m at 380 r.p.m, the discharge is10 m^3/s. If the efficiency is 95 % , determine i. specific speed of the machine ii. Power generated iii. type of the turbine.	Remember	CO 4	ACE011.16
7	A turbine develops 7357 Kw shaft power when running at 250 r.p.m. the head on the turbine is 45 m. If the head on the turbine is reduced to30 m, determine the speed and power developed by the turbine.	Understand	CO 4	ACE011.17
8	A pelton wheel is having a mean bucket diameter of 0.9 m and is running at 1050 r.p.m .The net head on the pelton wheel is 450 m .If the side clearance angle is 15^0 and discharge through the nozzle is 180 liters /sec. find i) power available at the nozzle , ii) hydraulic efficiency of the turbine .	Remember	CO 4	ACE011.16
9	A conical draft tube having inlet and out let diameters 1m and 1.5 m discharges water at outlet with a velocity of 3 m/s .The total length of draft tube is 10 m and 2.5m of the length of draft tube is immersed in water .If the atmospheric pressure head 10.8 m of water and loss of head due to friction in the draft tube is equal to 0.5 times the velocity head at out let of the tube, find i. pressure head at inlet and ii. Efficiency of draft tube.	Remember	CO 4	ACE011.16
10	A reaction turbine works at 520 r.p.m under a head of 120 m. the diameter of turbine at inlet is 110 cm and flow area is 0.45 m^2.The angles made by absolute and relative velocities at inlet are 15^0 and 60^0 respectively with the tangential velocity , determine i. The volume rate of flow ii. The power developed iii. Efficiency , assume whirl at outlet to be zero.	Remember	CO 4	ACE011.17
UNIT -V				
CENTRIFUGAL PUMPS				
Part - A (Short Answer Questions)				
1	Define pump and discuss about pump installation?	Remember	CO 5	ACE011.20
2	Discuss about classification of pumps?	Understand	CO 5	ACE011.19
3	Define the following :i) suction head ii) delivery head iii)static head	Remember	CO 5	ACE011.18
4	Define the following: i) Manometric efficiency ii) Mechanical efficiency iii) Overall efficiency.	Remember	CO 5	ACE011.18

5	Explain minimum speed for starting a centrifugal pump?	Remember	CO 5	ACE011.20
6	Define multi stage centrifugal pump?	Understand	CO 5	ACE011.20
7	Discuss about performance of pumps?	Remember	CO 5	ACE011.20
8	Draw the characteristic curves of pumps	Remember	CO 5	ACE011.19
9	Discuss about the classification of hydro power plants.	Remember	CO 5	ACE011.19
10	Define the following : i) Load factor ii) Utilization factor iii) Capacity factor	Remember	CO 5	ACE011.20
11	What do You understand by the term Net Positive Suction Head (NPSH)	Understand	CO 5	ACE011.20
12	What is priming and explain why it is necessary.	Remember	CO 5	ACE011.19
13	State the differences between single stage and multi stage pumps.	Understand	CO 5	ACE011.18
14	Enumerate the losses which occur when a centrifugal pump operates.	Understand	CO 5	ACE011.18
15	How are small and large centrifugal pumps primed?	Remember	CO 5	ACE011.20
16	Explain briefly about Volute casing, Vortex casing.	Remember	CO 5	ACE011.20
17	Explain briefly the effect of variation of discharge on the efficiency.	Understand	CO 5	ACE011.20
18	What do you mean by characteristic curves of a pump?	Understand	CO 5	ACE011.19
19	State the advantages of a centrifugal pump over reciprocating pump.	Understand	CO 5	ACE011.19
20	State the differences between single stage and multi – stage pumps.	Understand	CO 5	ACE011.20
	Part - B (Long Answer Questions)			
1	Define a centrifugal pump. Explain the working of a single –stage centrifugal pump with sketches.	Remember	CO 5	ACE011.20
2	Differentiate between the volute casing and vortex casing for the centrifugal pump. Obtain an expression for the work done by the impeller of a centrifugal pump on water per second per unit weight of water.	Remember	CO 5	ACE011.21
3	Define the terms: i) suction head, ii) delivery head iii) static head and iv) manometric head	Remember	CO 5	ACE011.19
4	A centrifugal pump is to discharge 0.118 m^3/s at a speed of 1450 r.p.m against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and monomeric efficiency is 75 %. Determine the vane angle at the outer periphery of the impeller.	Understand	CO 5	ACE011.20
5	A centrifugal pump running at 800 r.p.m is working against a total head of 20.2 m. The external diameter of the impeller is 480 mm and outlet width is 60 mm. If the vanes angle at outlet is 40^0 and manometric efficiency is70 %. Determine: a. Flow velocity at outlet. b. Absolute velocity of water leaving the vane. c. Angle made by the absolute velocity at outlet with the direction of motion at outlet, and d. Rate of flow through pump.	Understand	CO 5	ACE011.20
6	It is required to deliver 0.048 m^3/s is of water to a height of 24 m through a 150 mm diameter and 120 m long, by a centrifugal pump. If the overall efficiency of the pump is 75 % and co-efficient of friction, f = 0.01 for pipe line, find the power required to drive the pump.	Understand	CO 5	ACE011.20
7	A centrifugal impeller has dimensions and blade angles as given below. Water at the rate of 60 liters per second enters the impeller radially and the radial velocity remains constant in the impeller. Determine the impeller speed and torque produced by it. Use the following data: R_1 = 7.5 cm, R_2 = 15 cm, $\beta_1 = \beta_2 = 30^0$. Impeller inlet area – A1 = 250 cm^2.	Remember	CO 5	ACE011.20

8	A three stage centrifugal pump has impeller 400 mm in diameter and 20 mm wide. The vane angle at outlet is 45^0 and the area occupied by the thickness of the vanes maybe assumed 8 % of the total area. If the pump delivers 3.6 m^3 of water per minute when running at 920 r p m. Determine: a. Power of the pump. b. Manometric head c. Specific Speed Assume mechanical efficiency = 88 % and Manometric efficiency = 77 %.	Understand	CO 5	ACE011.21
9	Two geometrically similar pumps are running at the same speed of 1000 r. p.m. One has an impeller of 0.4 m and discharge of 30 l/s against a head of 20 m. If the other pump gives half of this discharge rate, determine the head and diameter of the second pump.	Remember	CO 5	ACE011.22
10	A centrifugal pump impeller has diameter at inlet and outlet as360 mm and 720 mm respectively. The flow velocity a t outlet is 2.5 m/s and the vanes are set back at an angle of 450 at the outlet. If the Manometric efficiency is 70 %, calculate the minimum starting speed of the pump.	Understand	CO 5	ACE011.20
11	A centrifugal pump delivers water against a net head of 14.5 m and a design speed of 1000 r.p.m. The vanes are curved back to an angle of 300 with the periphery. The impeller diameter is 30^0mm and outlet width is 50 mm. Determine the discharge of the pump if manometric efficiency is 95 %.	Remember	CO 5	ACE011.21
12	Find the power required to drive a centrifugal pump which delivers 0.04 m3/s of water to a height of 20 m through a 15 cm diameter pipe and 100 m long. The overall efficiency of the pump is 70% and co-efficient of friction f = 0.15in the formula	Understand	CO 5	ACE011.22
13	The internal and external diameters of the impellers of a centrifugal pump are 300 mm and 600 mm respectively. The pump is running at 1000 r. p.m. The vane angles at inlet and outlet are 200 and 300 respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water.	Understand	CO 5	ACE011.20
14	A centrifugal pump is to discharge 0.12 m^3 at a speed of 1400 r. p. m against a head of 30 m. The diameter and width of the impeller at outlet are 25 cm and 5 cm respectively. If the manometric efficiency is 75%. Determine the vane angle at outlet.	Understand	CO 5	ACE011.21
15	A three stage centrifugal pump has impeller 40 cm in diameter and 2.5 cm wide at outlet. The vanes are curved back at the outlet at 300 and reduce the circumferential area by 15%. The manometric efficiency is 85 % and overall efficiency is 75 %. Determine the head generated by the pump when running at 12000 r. p. m and discharge is 0.06 m^3/s. Find the shaft power also.	Understand	CO 5	ACE011.22
16	Find the number of pumps required to take water from a deep well under a total head of 156 m. Also the pumps are identical and are running at 1000 r. p.m. The specific speed of each pump is given as 20 while the rate capacity of each pump is 150 liters/s.	Understand	CO 5	ACE011.20
17	Find the height from the water surface at which a centrifugal pump may be installed in the following case to avoid cavitation. Atmospheric pressure = 1.01 bar; Vapour pressure = 0.022 bar; inlet and outlet losses in suction pipe = 1.42 m. Effective head of pump = 49 m and cavitation parameter = 0.015.	Understand	CO 5	ACE011.21
18	Tests on a pump model indicate a cavitation parameter = 0.10. A homogenous unit is to be installed at a location where atmospheric pressure = pa = 0.91 bar and vapour pressure = 0.035 bar absolute and is to pump water against at head of 25 m. What is the permissible suction head.	Remember	CO 5	ACE011.22

19	A centrifugal pump is discharging 0.025 m3/s of water against a total head of 18 m. The diameter of the impeller is 0.4 m and it is rotating at 1400 r. p.m. Calculate the head, discharge and ratio of powers of a geometrically similar pump of diameter 0.25 m when it is running at 2800 r. p. m.	Remember	CO 5	ACE011.20
20	A centrifugal pump runs at 500 r. p. m and delivers 300 m3 / min of water against a head of 120m. the pump impeller is 2 m in diameter and it has a positive suction lift including the velocity head and friction of 3 m. Laboratory tests are to be conducted on a model with 450 mm diameter impeller and on reduced head of 95 m. Assuming atmospheric head = 10.15 m of water and vapur head = 0.34 m of water calculate speed, discharge and suction lift for the laboratory tests.	Remember	CO 5	ACE011.21
	Part – C (Problem Solving and Critical Thinking)			
1	Find the height from the water surface at which a centrifugal pump may be installed in the following case to avoid cavitation. Atmospheric pressure = 1.0 bar; Vapour pressure = 0.025 bar; inlet and outlet losses in suction pipe = 1.42 m. Effective head of pump = 55 m and cavitation parameter = 0.020.	Understand	CO 5	ACE011.20
2	A centrifugal pump is discharging 0.035 m3/s of water against a total head of 15m. The diameter of the impeller is 0.5 m and it is rotating at 1500 r. p.m. Calculate the head, discharge and ratio of powers of a geometrically similar pump of diameter 0.6m when it is running at 2600 r. p. m.	Remember	CO 5	ACE011.20
3	The internal and external diameters of the impellers of a centrifugal pump are 500 mm and 800 mm respectively. The pump is running at 1050 r. p.m. The vane angles at inlet and outlet are 400 and 600 respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water.	Remember	CO 5	ACE011.21
4	Define the terms i)suction head ii)delivery head iii)static head iv)monomeric head with neat sketch	Remember	CO 5	ACE011.22
5	A centrifugal pump is to discharge 0.128 m^3/s at a speed of 1550 r.p.m against a head of 30 m. The impeller diameter is 200 mm, its width at outlet is 58 mm and monomeric efficiency is 80 %. Determine the vane angle at the outer periphery of the impeller.	Remember	CO 5	ACE011.20
6	Find the power required to drive a centrifugal pump which delivers 0.05 m3/s of water to a height of 30 m through a 22 cm diameter pipe and 125 m long. The overall efficiency of the pump is 70% and co-efficient of friction f = 0.20in the formula.	Understand	CO 5	ACE011.20
7	Tests on a pump model indicate a cavitation parameter = 0.20. A homogenous unit is to be installed at a location where atmospheric pressure = pa = 0.95 bar and vapour pressure = 0.045 bar absolute and is to pump water against at head of 30 m. What is the permissible suction head?	Remember	CO 5	ACE011.20
8	Two geometrically similar pumps are running at the same speed of 1100 r. p.m. One has an impeller of 0.6 m and discharge of 35 l/s against a head of 25 m. If the other pump gives half of this discharge rate, determine the head and diameter of the second pump.	Understand	CO 5	ACE011.20
9	A centrifugal impeller has dimensions and blade angles as given below. Water at the rate of 95 liters per second enters the impeller radially and the radial velocity remains constant in the impeller. Determine the impeller speed and torque produced by it. Use the following data: R_1 = 10 cm, R_2 = 20 cm, $\beta_1 = \beta_2 = 45^0$. Impeller inlet area – A1 = 280 cm^2.	Remember	CO 5	ACE011.21

10	A three stage centrifugal pump has impeller 450 mm in diameter and 10 mm wide. The vane angle at outlet is 60^0 and the area occupied by the thickness of the vanes maybe assumed 10 % of the total area. If the pump delivers 4.5 m^3 of water per minute when running at 950 r p m. Determine: a. Power of the pump. b. Manometric head c. Specific speed Assume mechanical efficiency = 90 % and Manometric efficiency = 75 %.	Remember	CO 5	ACE011.22

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