INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING
TUTORIAL QUESTION BANK

Course Name	**MECHANICS OF FLUIDS & HYDRAULIC MACHINES**
Course Code	**AME008**
Class	IV Semester
Branch	MECHANICAL ENGINEERING
Year	2018 – 2019
Course Coordinator	Mr. A. Somaiah, Assistant Professor, M.E
Course Faculty	Dr. CH.V.K.N.S.N Moorthy, Professor, M.E Mr. A. Somaiah, Assistant Professor, M.E

COURSE OBJECTIVES (COs):

The course should enable the students:

I	Understand the basic principles of fluid mechanics
II	Identify various types of flows.
III	Understand boundary layer concepts and flow through pipes
IV	Evaluate the performance of hydraulic turbines.
V	Understand the functioning and characteristic curves of pumps.

COURSE LEARNING OUTCOMES (CLOs):

Students, who complete the course, will have demonstrated the ability to do the following:

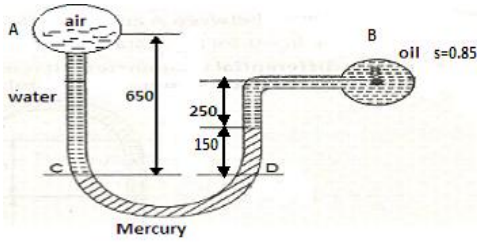
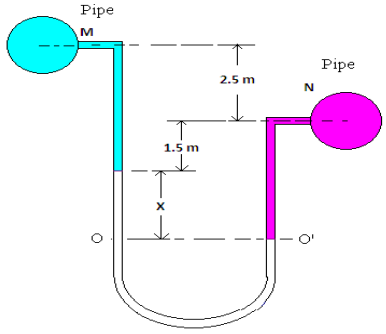
CLO Code	At the end of the course, the student will have the ability to:
AME008.01	Define the properties of fluids and its characteristics, which will be used in aerodynamics, gas dynamics, marine engineering etc.
AME008.02	Explain the hydrostatic forces on submerged bodies, variation with temperature and height with respect to different types of surfaces.
AME008.03	Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its metacenter height.
AME008.04	Define fluid kinematics and classification of flows, concepts of stream function and velocity potential function which provides solution for velocity and acceleration of fluid flow in real time applications.
AME008.05	Explain one dimensional, two dimensional flows in wind tunnel with classification of both compressible and in compressible flows in continuity equation.
AME008.06	Recognize the surface and body forces required for obtaining momentum equation and energy equation and explain types of derivatives utilized in various flow field conditions.
AME008.07	Develop Bernoulli's equation from Euler's equation and explain phenomenological basis of Navier – stokes equation which are widely used in aerodynamics and gas dynamics for real time problems.
AME008.08	Demonstrate Buckingham's π theorem and explain similarity parameters used for scale down models and explain flow measurements with dimensionless parameters.
AME008.09	Demonstrate for competitive exams, the concepts of boundary layer and qualitative description of boundary layer thickness and velocity profile on a flat plate.
AME008.10	Distinguish the pressure drag and skin friction drag and state the relation between the frictions of both the drags.

AME008.11	Demonstrate the various types of major and minor losses in pipes and explain flow between parallel plates.
AME008.12	Discuss fully developed flow through pipes and variation with friction factor with Reynolds number and sketch the Moody's chart.
AME008.13	Describe the concepts of turbo machinery in the field of aerospace engineering and concepts of internal flows through engines.
AME008.14	Explain types of hydraulic pumps, the basic functions and features.
AME008.15	Design and select pumps (single or multiple) for different hydraulic applications.
AME008.16	Understand pumps classification and be able to develop a system curve used in pump selection
AME008.17	Analyze flow in closed pipes, and design and selection of pipes including sizes.
AME008.18	Understand the basic elements of pump and turbine flow, and be able to analyze and select the pump needed for pressurizing situations.
AME008.19	Recognize and discuss today's and tomorrow's use of turbo machines for enabling a sustainable society.
AME008.20	Explain the working principle of various types of hydro turbines and know their application range
AME008.21	Determine the velocity triangles in turbomachinery stages operating at design and off design conditions.

TUTORIAL QUESTION BANK

UNIT – I			
FLUID STASTICS			
Part - A (Short Answer Questions)			
S No	**QUESTION**	**Blooms Taxonomy Level**	**Course Learning Outcomes**
1	Define mass density and state its SI units	Understand	AME008.01
2	Define Weight density and state its SI units	Remember	AME008.02
3	Define Specific volume and state its SI units	Understand	AME008.03
4	Define specific gravity of a fluid and state its SI units	Remember	AME008.04
5	Differentiate between Liquids and gases	Understand	AME008.01
6	Differentiate between Real fluids and ideal fluids	Remember	AME008.02
7	Differentiate between Specific weight and specific volume of a fluid.	Understand	AME008.03
8	Differentiate between Newtonian and non-newtonian fluids	Remember	AME008.04
9	Define dynamic viscosity and state its units	Understand	AME008.01
10	Define and explain Newton's law of viscosity.	Remember	AME008.02
11	Why does the viscosity of a gas increases with the increases in temperature while that of a liquid decreases with increase in temperature?	Understand	AME008.03
12	One litre of crude oil weighs 9.6N.calculate its specific weight, density and specific gravity.	Remember	AME008.04
13	Define vapour pressure	Understand	AME008.01
14	Define cavitation	Remember	AME008.02
15	Define surface tension	Understand	AME008.03
16	Define the property of capillarity	Remember	AME008.04
17	Define kinematic viscosity and state its units	Remember	AME008.01

18	Differentiate between compressible and in compressible fluids	Remember	AME008.02
19	What is a piezometer?	Understand	AME008.03
20	Define differential manometer	Understand	AME008.04
Part - B (Long Answer Questions)			
1	Explain in detail mass density, write its units and explain the effect of temperature and pressure on mass density	Understand	AME008.01
2	Explain in detail weight density, write its units and explain the effect of temperature and pressure on weight density	Remember	AME008.02
3	Derive the relation between the mass density and weight density	Understand	AME008.03
4	Explain in detail specific gravity, write its units and explain the effect of temperature and pressure on specific gravity	Remember	AME008.04
5	Explain with a neat sketch the viscosity, newton's law of viscosity, and the effect of temperature and pressure on viscosity	Understand	AME008.01
6	Explain in detail the kinematic and dynamic viscosity and derive the relation between them.	Remember	AME008.02
7	Explain in detail the formation of vapour pressure, cavitation and capillarity with examples.	Understand	AME008.01
8	Explain with neat sketch atmospheric, gauge and vacuum pressure with suitable examples	Remember	AME008.03
9	The pressure 3 metre below the free surface of a liquid is 13.72 kN/m^2. Determine its specific weight	Understand	AME008.04
10	If the pressure at a point below the sea is 137.7kN/m^2, what is the pressure 30m below this point? Specific weight of ocean water is 10.06 kN/m^2.	Remember	AME008.02
11	An oil of specific gravity 0.80 is under a pressure of 137.2 kN/m^2. What is the pressure head expressed in metres of oil?	Understand	AME008.04
12	An oil of specific gravity 0.80 is under a pressure of 137.2 kN/m^2. What is the pressure head expressed in metres of water?	Remember	AME008.02
13	How thick is the layer of liquid mud(specific gravity 1.6) at the bottom of a river with water 8 m deep, if there is a pressure of 343 kN/m^2 at the bottom of the mud? Treat the mud as a fluid	Understand	AME008.03
14	Two pipes are connected with an inverted U-tube differential manometer. Pipe A to the left limb and Pipe B to the right limb. Water is flowing through the pipes. The water level in the left limb connected to pipe A is 165cm. The difference of water level in the two limbs is 25cm and the level in the right limb is lower than that of the left limb. The difference of the level between two pipe centres is 50cm. Manometric fluid is the oil with specific gravity 0.9. Sketch the set up and determine the pressure difference between the pipes A and B.	Understand	AME008.04
15	How can you measure pressure by using differential manometers?	Understand	AME008.01
16	Explain different ways of expressing pressure and derive the relation between each other	Remember	AME008.02
17	Under what conditions is the miniscus between two liquids in a glass tube (i) concave upwards and (ii) concave downwards?	Understand	AME008.03
18	Define and Explain a fluid fom mechanics point of view.	Remember	AME008.04
19	Explain in detail different types of fluids with a neat sketch of the graph	Understand	AME008.01
20	Define and explain why the following phenomena happen in fluids (i) spherical shape of a drop of liquid (ii) cavitation	Understand	AME008.02

Part - C (Problem Solving and Critical Thinking Questions)			
1	a) Explain the terms surface tension and vapor pressure. b) A 40 mm diameter shaft is rotating at 200 rpm in a bearing of length 120 mm. if the thickness of oil film is 1.5mm and dynamic viscosity of oil is 0.7Ns/m^2. Determine i) torque required to overcome friction in bearing, ii) power utilized in overcoming viscous resistance.	Remember	AME008.02
2	a) State Newton's law viscosity and explain how viscosity varies with temperature for liquids and gases. b) Figure shows a differential manometer connected at two points A & B at A air pressure is 100 KN/m^2. Determine the absolute pressure at B 	Understand	AME008.03
3	a) An oil film of thickness 1.5mm is used for lubrication between a square plate of size 0.9m x 0.9m and an inclined plane having an angle of inclination 20^0. The weight of the square is 392.4 N and it slides down the plane with a uniform velocity of 0.2 m/s. Determine the dynamic viscosity of the oil. b) Define atmospheric, gauge and vacuum pressures with examples.	Remember	AME008.04
4	a) Define viscosity and derive Newton's law of viscosity. b) If the velocity distribution over a plate is given by u = (2/3)y – y^2, in which 'u' is the velocity in m/s at a distance 'y' meter above the plate, determine the shear stress at y=0 and y=0.15m. Take dynamic viscosity of fluid as 8.63 poise.	Understand	AME008.01
5	a) Differentiate between U-tube and Inverted U-Tube differential manometers. b) As shown in fig, pipe M contains carbon tetrachloride of specific gravity 1.594 under a pressure of 1.05 Kgf/cm^2 and pipe N contains oil of specific gravity 0.8. If the pressure in the pipe N is 1.75 Kgf/cm^2 and the manometric fluid is mercury. Determine the difference 'X' between the levels of mercury. 	Remember	AME008.02

6	a) An oil film of thickness 1.5mm is used for lubrication between a square plate of size 0.9m x 0.9m and an inclined plane having an angle of inclination 20^0. The weight of the square is 392.4 N and it slides down the plane with a uniform velocity of 0.2 m/s. Determine the dynamic viscosity of the oil. b) Define atmospheric, gauge and vacuum pressures with examples.	Remember	AME008.03
7	a) An inverted u-tube manometer is connected to two horizontal pipes A & B through which water is flowing. The vertical distance between the axes of these points is 30 cm. When an oil of sp. gravity 0.8 is used as a gauge fluid, the vertical heights of water columns in the two limbs of the inverted manometer (when measured from the respective center lines of the pipes) are found to be same and equal to 35 cm. Determine the difference of pressure between the pipes. b) Derive an expression for surface tension on a liquid droplet.	Understand	AME008.04
8	a) Derive an expression for surface tension on a liquid jet. b) The surface tension of water in contact with air 20^0c is given as 0.0716N/m .The pressure inside the drop let of water is to be 0.0417N/cm^2 greater than the outside pressure. Calculate the diameter of the droplet of water.	Remember	AME008.01
9	a) The velocity profile of a viscous fluid over a plate is parabolic with vertex 20cm from the plate, where the velocity is 120cm/s. calculate the velocity gradient and shear stress at distance of 0.5 and 15cm from the plate, given the viscosity of the fluid =6 poise. b) Define specific gravity, specific volume and weight.	Understand	AME008.02
10	a) An oil film of thickness 1.5mm is used for lubrication between a square plates is of size 0.9m x 0.9m and an inclined plane having an angle of inclination 20^0. The weight of the square is 392.4N and it slides down the plane with a uniform velocity of 0.2 m/s. Calculate the dynamic viscosity of the oil. b) How do you measure the pressure by using manometers and mechanical gauges?	Remember	AME008.03

UNIT - II

FLUID KINEMATICS, FLUID DYNAMICS

Part – A (Short Answer Questions)

S No	QUESTION	Blooms Taxonomy Level	Course Learning Outcomes
1	Explain stream line flow pattern.	Understand	AME008.05
2	Explain path line flow pattern.	Remember	AME008.06
3	Explain streak line flow pattern	Understand	AME008.07
4	Explain stream tube	Remember	AME008.08
5	Differentiate steady and unsteady flow.	Understand	AME008.05
6	Differentiate uniform and non uniform flow	Remember	AME008.06
7	Differentiate laminar and turbulent flow	Understand	AME008.07
8	Differentiate rotational and irrotational flow	Remember	AME008.08
9	Write the impulse momentum equation	Understand	AME008.05
10	Write the continuity equation for an incompressible, 1-D and steady flow	Remember	AME008.06
11	What forces are included in Reynold's equation?	Understand	AME008.07

12	What forces are included in Navier Stoke's equation	Remember	AME008.08
13	What forces are included in Euler's equation	Understand	AME008.06
14	What are line forces?	Remember	AME008.08
15	What are body forces?	Understand	AME008.05
16	What are surface forces?	Remember	AME008.07
17	Write the assumptions of Bernoulli's equation	Understand	AME008.06
18	What is the principle of Continuity equation?	Remember	AME008.05
19	What is the principle of Bernolli's equation?	Remember	AME008.08
20	Discuss about surface and body forces	Understand	AME008.06
Part - B (Long Answer Questions)			
1	Discuss in detail about different types of flows and also explain the steady flow with its mathematical expressions.	Understand	AME008.06
2	What are flows? Explain in detail Unsteady of flow with its mathematical expressions.	Remember	AME008.07
3	Explain in detail about Uniform flow with its mathematical expressions.	Understand	AME008.08
4	Discuss the importance of non Uniform flow in fluid kinematics.	Remember	AME008.05
5	With a suitable diagram explain in detail about laminar flows.	Understand	AME008.06
6	Write different types of flows and explain in detail about turbulent flow with suitable diagrams.	Remember	AME008.07
7	Elaborate different types of flows and explain in rotational flow with suitable examples.	Understand	AME008.08
8	Write different types of flows and explain in detail irrotational flow with suitable examples.	Remember	AME008.05
9	Classify the patterns of flow and explain in detail with neat sketch the Stream line flow	Understand	AME008.06
10	Classify the patterns of flow and explain in detail with neat sketch the Streak line flow	Remember	AME008.07
11	Classify the patterns of flow and explain in detail the path line flow and stream tube	Understand	AME008.08
12	Classify and Explain different types of forces acting on a fluid flow	Remember	AME008.05
13	State the principle of continuity equation. Derive the general 3-D continuity equation for a fluid flow	Understand	AME008.06
14	State the principle of continuity equation. Derive the 1-D continuity equation for a fluid flow along a stream line flow	Remember	AME008.07
15	Derive Euler's equation for a fluid flow along a stream line also state it's assumptions.	Understand	AME008.08
16	State the principle and Derive Bernoulli's equation for a fluid flow along a stream line.	Remember	AME008.05
17	State the assumptions of Bernoulli's equation and list the applications of Bernoulli's equation	Understand	AME008.06
18	State and derive the momentum equation. Also list out the applications of the equation.	Remember	AME008.07
19	Apply momentum equation to a pipe bend and derive expressions for forces acting on it.	Understand	AME008.08
20	Explain the terms fluid statics, fluid dynamics, fluid kinetics and fluid kinematics	Remember	AME008.05

Part – C (Problem Solving and Critical Thinking)			
1	a) Define path line, stream line steam tube and streak line. b) Water flows through a pipe AB 1.2 m dia. at 3m/s and then pass through pipe BC 1.5 m dia. At C the pipe branches, branch CD is 0.8 m dia. And carries $1/^{3}$ rd of the flow in AB the flow velocity in branch CE is 2.5 m/s. Calculate the volume rate of flow in AB, the velocity in BC, the velocity in CD and dia. of CE.	Understand	AME008.06
2	a) Define and state the applications of momentum equation. b) A 45^{0} reducing bend is connected in a pipe line, the diameters at the inlet and outlet of the bend being 40cm and 20cm respectively. Find the force exerted by water on the bend, if the intensity of the pressure at inlet of bend is 21.58N/cm^{2}. The rate of flow of water is 500 liters per second.	Understand	AME008.07
3	a) State the assumptions and derive Bernoulli's equation for flow along a stream line. b) Define and state examples of following flows i) Steady and unsteady ii) Laminar and turbulent	Remember	AME008.06
4	a) Explain body force, surface force and line force with examples b) How impulse momentum equation can be applied for the force exerted by fluid on the bend pipe.	Understand	AME008.07
5	a) The velocity vector in a flow field is given as V = $4x^{3}i - 10\ x^{2}yj + 2tk$. Determine the velocity and acceleration of a fluid particle at (2, 1, 3) at time=1. b) Derive continuity equation in one dimensional flow.	Remember	AME008.08
6	a) Derive continuity an expression for continuity equation in three dimensional flows. b) The water is flowing through a pipe having diameters 20cm and 15cm at sections 1 and 2 respectively. The rate of flow through pipe is 40 ltr/s. The section 1 is 6 m above datum line and section 2 is 3m above the datum. If the pressure at section 1 is 29.43 N/cm^{2}, Calculate the intensity of pressure at section 2.	Understand	AME008.05
7	a) 250 lps of water is flowing in a pipe having a diameter of 300 mm. If the pipe is bent by 135^{0} find the magnitude and the direction of the resultant force on the bend. The pressure of water flowing is 39.24 N/cm^{2}. b) Define rotational and irrotational flows with examples.	Remember	AME008.08
8	a) a pipe of diameter 400 mm carries water at a velocity of 25 m/s. the pressure at the points A & B are given as 29.43 N/cm^{2} and 22.563 N/cm^{2} respectively, while the datum head at A and B are 28 m and 30 m. Calculate the loss of head at A and B. b) Define uniform and non-uniform flows with examples.	Understand	AME008.07
9	a) The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 lps. The pipe has a slope of 1 in 30; determine the pressure at lower end if pressure at higher level is 19.62 N/cm^{2}. b) Derive an expression for Euler's equation of a flow along a stream line.	Remember	AME008.06

10	a) A 300 mm diameter pipe carries water under a head of 20 m with a velocity of 3.5 m/s. If the axis of the pipe turns through 45^0, calculate the magnitude and the direction of the resultant force at the bend. b) Define compressible and in-compressible flows	Understand	AME008.05

UNIT-III (CIE-I)			
BOUNDARY LAYER CONCEPTS, CLOSED CONDUIT FLOW			
Part - A (Short Answer Questions)			
S No	**QUESTION**	**Blooms Taxonomy Level**	**Course Learning Outcomes**
1	Write the condition of Reynold's number for Laminar boundary layer region	Understand	AME008.10
2	What is the separation of boundary layer?	Remember	AME008.09
3	Discuss about laminar flow?	Understand	AME008.10
4	Define is turbulence flow?	Remember	AME008.11
5	Write Darcy weisbach equation and chezyes formula.	Understand	AME008.12
6	Define is an Orifice?	Remember	AME008.11
7	What is the condition for boundary layer separation	Understand	AME008.10
8	Explain the function of flow nozzle?	Remember	AME008.09
9	Write short notes on drag.	Understand	AME008.10
10	Explain the formation of lift.	Remember	AME008.11
11	What is the expression for boundary layer thickness?	Understand	AME008.12
12	Sketch the boundary layer formation over the flat plate	Remember	AME008.09
13	Name the region at the end of the plate after boundary layer formation	Understand	AME008.10
14	Write the expression for momentum thickness	Remember	AME008.11
15	What is transition flow?	Understand	AME008.12
Part – B (Long Answer Questions)			
1	Explain with neat sketch different regions of boundary layer when a fluid is flowing over a horizontal flat plate.	Understand	AME008.09
2	Derive an expression for loss of head due to friction for a pipe through which fluid flows.	Remember	AME008.10
3	Explain losses of head due at inlet of pipe, at outlet of a pipe, due to obstruction in a pipe.	Understand	AME008.11
4	Explain how to construct a hydraulic gradient and total energy line, with a neat sketch.	Remember	AME008.12
5	Describe the working of a Venturi meter with a neat sketch and state it's working principle.	Understand	AME008.10
6	Describe the working of an orifice meter with a neat sketch and state it's working principle.	Remember	AME008.12
7	What will happen when the pipes are connected in series and in parallel?	Understand	AME008.11
8	Derive an expression for loss of head due to sudden enlargement of a pipe.	Remember	AME008.09

9	Derive an expression for loss of head due to sudden contraction of a pipe	Understand	AME008.10
10	Explain the phenomena of boundary layer separation with neat sketch.	Remember	AME008.11
Part – C (Problem Solving and Critical Thinking)			
1	a. Derive an expression for displacement thickness due to formation of boundary layer. b. Define boundary layer and boundary layer thickness.	Understand	AME008.10
2	c. Define drag and lift on a submerged body? d. For the velocity profile $2(y/\delta)- (y/\delta)^2$, find the thickness of boundary layer at the end of the plate and the drag force on one side of a plate 1 m long and 0.8 m wide when placed in water flowing with a velocity of 150 mm/s. calculate the value of coefficient of drag also. Take μ for water as 0.01 poise.	Remember	AME008.10
3	a. Define displacement thickness, momentum thickness and energy thickness. b. Calculate the displacement thickness, momentum thickness for the velocity distribution in the boundary layer given by $u/U=2(y/_{\delta}) – \left(\frac{y}{\delta}\right)^2$	Understand	AME008.09
4	a. Define energy thickness, momentum thickness and boundary layer thickness. b. Derive an expression for momentum thickness of boundary layer.	Remember	AME008.10
5	a. Derive Darcy-Weisbach eauation. b. A crude oil of kinematic viscosity and 0.4 stoke is flowing through a pipe of diameter 300 mm at the rate of 300 lps. Find the head loss due to friction for a length of 50 m of the pipe.	Understand	AME008.11
UNIT-III (CIE-II)			
BOUNDARY LAYER CONCEPTS, CLOSED CONDUIT FLOW			
Part - A (Short Answer Questions)			
S No	**QUESTION**	**Blooms Taxonomy Level**	**Course Learning Outcomes**
1	What is the maximum value of the C_d of a venturi meter?	Understand	AME008.10
2	What is the maximum value of the C_d of a orifice meter?	Remember	AME008.09
3	Write the expression for the head loss at entrance	Understand	AME008.11
4	Explain the expression for the head loss at exit	Remember	AME008.12
5	Write the expression for the head loss due to sudden enlargement	Understand	AME008.10
6	Describe the expression for the head loss due to sudden contraction	Remember	AME008.12
7	Write the expression for the head loss due to sudden obstruction	Understand	AME008.11
8	What is the expression for the head loss due to pipe bend?	Remember	AME008.09
9	Describe the expression for the head loss due to pipe fitting	Understand	AME008.10
10	Write chezeys formulae.	Remember	AME008.11
11	What is meant by vena contracta?	Understand	AME008.12
12	What is meant by TEL?	Remember	AME008.12
13	What is meant by HGL?	Understand	AME008.11
14	What is the purpose of pitot tube?	Remember	AME008.10

15	Write the purpose of venture meter.	Understand	AME008.11
Part – B (Long Answer Questions)			
1	Describe the working of a pitot tube with a neat sketch. Also state its applications.	Remember	AME008.09
2	Explain in detail the Reynold's experiment with neat sketch and express the equation for Reynold's number	Understand	AME008.11
3	Define drag and explain the difference between pressure drag and friction drag	Remember	AME008.10
4	Derive Von-Karman's momentum integral equation and discuss methods of controlling boundary layer thickness.	Understand	AME008.11
5	Derive the equation for displacement thickness of a boundary layer and discuss about laminar sub layer.	Remember	AME008.10
6	Derive the equation for momentum thickness of a boundary layer and discuss the laminar boundary layer.	Understand	AME008.09
7	Derive the equation for energy thickness of a boundary layer and discuss the turbulent boundary layer.	Remember	AME008.10
8	Derive the expression for the Coefficient of discharge through a Venturi meter.	Understand	AME008.11
9	Derive the expression for the Coefficient of discharge through an orifice meter	Remember	AME008.12
10	Derive an expression for the ratio of Length to diameter of a compound pipe	Understand	AME008.11
Part – C (Problem Solving and Critical Thinking)			
1	a) Derive an expression for energy loss, if the pipe is suddenly enlarged? b) A horizontal pipe of diameter 500 mm is suddenly contracted to a diameter of 250 mm. The pressure intensities in the large and smaller pipe is given as 13.734 N/cm^2 and 11.772 N/cm^2 respectively. Find the loss of head due to contraction if Cc = 0.62. Also determine the rate of flow of water.	Remember	AME008.10
2	a) Define HGL and TEL with a neat sketch. b)A pipe of diameter 20 cm and length 2000 m connects two reservoirs, having difference of water levels as 20 m. Determine the discharge through the pipe. If an additional pipe of diameter 20 cm and length 1200 m is attached to the last 1200 m length of the existing pipe, calculate the increase in the discharge. Take f = 0.015 and neglect minor losses.	Understand	AME008.11
3	a) Derive an expression for loss of head due to sudden contraction of a pipe. b) A horizontal pipe line 40 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 m of its length from the tank is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the centre of the pipe. Considering all losses of head which occur, determine the rate of flow. Take f = 0.01 for both sections of the pipe, also draw HGL and TEL.	Remember	AME008.12
4	a) Derive an expression for discharge through the venture meter. b) A horizontal venturimeter with inlet and throat diameters 30 cm and 15 cm respectively is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20 cm of mercury. Determine the rate of flow. Take Cd = 0.98.	Understand	AME008.08

5	a) Derive an expression for discharge through an orifice meter. b) An orifice meter with orifice diameter 15 cm is inserted in a pipe of 30 cm diameter. The pressure difference measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50 cm of mercury. Find the rate of flow of oil of specific gravity 0.9 when the co-efficient of discharge of the meter = 0.64.	Remember	AME008.09

UNIT-IV			
BASICS OF TUBRO MACHINERY, HYDRAULIC TURBINES AND PERFORMANCE			
Part – A (Short Answer Questions)			
S No	**QUESTION**	**Blooms Taxonomy Level**	**Course Learning Outcomes**
1	Differentiate impulse and reaction turbines.	Understand	AME008.13
2	What is specific speed?	Remember	AME008.14
3	Mention different specific speeds for different turbines.	Understand	AME008.15
4	What is the purpose of draft tube?	Remember	AME008.16
5	What is mass curve?	Understand	AME008.13
6	Differentiate axial and radial flow turbines.	Remember	AME008.14
7	What are the different heads in turbines?	Understand	AME008.15
8	How governing of a turbine takes place?	Remember	AME008.16
9	How cavitation occurs?	Understand	AME008.13
10	What are unit quantities?	Remember	AME008.14
11	What is overall efficiency of turbine?	Understand	AME008.15
12	When do you use pelton wheel turbine?	Remember	AME008.16
13	Name different types of draft tubes	Understand	AME008.13
14	What is water hammer?	Remember	AME008.14
15	Draw O.C curves for turbines	Understand	AME008.15
16	What is the force exerted by the jet of water on flat moving inclined plate?	Remember	AME008.16
17	Write formulae for unit speed and unit power	Understand	AME008.13
18	Draw the velocity triangles in the jet of water striking at the tip of unsymmetrical moving curved vane.	Remember	AME008.14
19	What is the formula for draft tube efficiency?	Understand	AME008.15
20	What is the efficiency of radial curved vane?	Remember	AME008.16
Part – B (Long Answer Questions)			
1	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 m^3/s, determine power available at the nozzle and hydraulic efficiency of the turbine.	Understand	AME008.17

2	A jet of water 75 mm in diameter having velocity of 20 m/s strikes a series of the flat plates arranged around the periphery of a wheel such that each plate appears successively before the jet. If the plates are moving at a velocity of 5 m/s, calculate the force exerted by the jet on the plate, the work done per second on the plate and the efficiency of the jet.	Remember	AME008.18
3	A jet of water of diameter 60mm moving with a velocity of 40 m/sec, strikes a curved fixed symmetrical plate at the centre. Determine the force exerted by the jet of water in the direction of the jet, if the jet is deflected by an angle of 160 degrees at the outlet of the curved plate.	Understand	AME008.13
4	A jet of water 50 mm in diameter issues with a velocity of 10m/sec and impinges normally on a stationary flat plate which moves in forward motion. Determine the force exerted by the jet on the plate and the work done.	Understand	AME008.14
5	Derive an expression for work done/sec and efficiency when the jet of water striking tangentially at the tip of the vane of an un symmetrical curved vane.	Remember	AME008.15
6	Derive work done and efficiency when the jet of water striking tangentially of a radial curved vanes.	Understand	AME008.16
7	Explain the concept of pumped storage plants.	Remember	AME008.13
8	Two turbo-generators each of capacity 25000kW have been installed at a hydel power station. During a certain period the load on the hydel plant varies from 15000kW to 4000kW. Calculate i. The total installed capacity, ii. The load factor, iii. The plant factor and iv. The utilization factor	Understand	AME008.14
9	Derive an expression for efficiency of a series of radial curved vanes when the jet of water striking the vanes.	Remember	AME008.15
10	A jet of water having a velocity of 35m/s impinges on a series of vanes moving with a velocity of 20m/s the jet makes an angle of 30^0 to the director of motion of vanes. When entering and leaves at angle of 120^0 draw the inlet and outlet velocity triangles and find a. The angles of vane tips so that water enters and leaves without shock. b. The workdone per unit weight of water c. Efficiency	Understand	AME008.14
11	A jet of water of diameter 50mm, having a vel of 20m/s. strikes a curved vane which moving a velocity of 10m/s in the direction of the jet. The jet leaves the vane at an angle of 60^0 to the direction of motion of vane at outlet. Determine. i. The force exerted by the jet on the vane in the dirn of motion ii. WD/sec by the jet.	Remember	AME008.13
12	How to govern the impulse turbines? Explain with a neat sketch.	Understand	AME008.14
13	A turbine develops 9000 KW when running at 100 rpm. The head on the turbine is 30 m. if the head on the turbine reduced to 18m, determine the speed and power developed by the turbine.	Remember	AME008.15
14	What is the necessity of a surge tank in turbines. Explain different types of surges with the aid of neat diagrams.	Understand	AME008.16

15	A hydraulic turbine under a head of 25 metres develops 7260 kW running at 110 rpm. What is the specific speed of the turbine? What types of turbine is this. Find also the normal speed and output if the head on the turbine is reduced to 20 metres.	Remember	AME008.14
16	a) Explain the working of a Pelton wheel with neat sketches? b) A Francis turbine works under a head of 8.5 m at a speed of 300 rpm. A power of 100 KW is developed with a discharge of 3 m3/sec. The runner diameter is 2.2 m. Find the speed, discharge and power if the head is increased to 18m.	Understand	AME008.13
17	Define unit Head, unit discharge and unit power of a turbine and derive the expressions for the same.	Remember	AME008.15
18	A hydraulic turbine working under a head of 165 metres runs at 300 rpm, the discharge of the turbine being 0.60m^3/sec. The overall efficiency of the turbine is 85%. Find the type of turbine.	Understand	AME008.15
19	A turbine is to operate under a head of 30 metres at 250 rpm. The discharge is 10.5m^3/sec. if the efficiency is 85% determine i. Power generated ii. The specific speed of the turbine iii. Type of turbine iv. Performance under a head of 25 metres.	Remember	AME008.16
20	a) How do you achieve the governing of turbines? Explain with neat sketches. b) Discuss the different characteristic curves of turbines?	Understand	AME008.13
Part – C (Problem Solving and Critical Thinking)			
1	a) Differentiate the impulse and reaction turbines. b) A jet of water 50 mm in diameter issues with a velocity of 10m/sec and impinges normally on a stationary flat plate which moves in forward motion. Determine the force exerted by the jet on the plate and the work done.	Remember	AME008.13
2	a) Give the classification of turbines. b) A jet of water of diameter 60mm moving with a velocity of 40 m/sec, strikes a curved fixed symmetrical plate at the centre. Determine the force exerted by the jet of water in the direction of the jet, if the jet is deflected by an angle of 160 degrees at the outlet of the curved plate.	Understand	AME008.14
3	a) Define the following; i. Unit speed ii. Unit discharge iii. Unit power iv. Degree of reaction b) 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 m^3/s, determine power available at the nozzle and hydraulic efficiency of the turbine.	Remember	AME008.15
4	a) Define the following efficiencies; i. Mechanical ii. Volumetric iii. Overall iv. Hydraulic b) A Pelton wheel is having a mean bucket diameter of 1 m and is running at 1000 rpm. The net head on the Pelton wheel is 700 m. if the side clearance angle is 15^0 and discharge through nozzle is 0.1m^3/s, calculate: i. Power available at the nozzle, and ii. Hydraulic efficiency of the turbine.	Understand	AME008.16

5	a) A jet of water 75 mm in diameter having velocity of 20 m/s strikes a series of the flat plates arranged around the periphery of a wheel such that each plate appears successively before the jet. If the plates are moving at a velocity of 5 m/s, calculate the force exerted by the jet on the plate, the work done per second on the plate and the efficiency of the jet. b) Derive an expression for force exerted by fluid jet on moving flat plate.	Remember	AME008.13
6	a) A Pelton wheel is to be designed for the following specifications. Shaft power = 735.75 KW, head = 200 m, speed = 800 rpm, overall efficiency = 0.86 and jet diameter not to exceed $1/10^{th}$ of wheel diameter. Determine i. wheel diameter, ii. No. of jets required and iii. Diameter of jet. Take Cv=0.98 and Kv=0.45. b) Explain the function of draft tube.	Understand	AME008.14
7	a) Draw and explain OC curves of turbines under constant head. b) A turbine is to operate under a head 25 m at 200 rpm. The discharge is 9 cumec. If the efficiency is 90% , determine the performance of the turbine under head of 20 m.	Remember	AME008.15
8	a) How to govern the impulse turbines? Explain with a neat sketch. b) A turbine develops 9000 KW when running at 100 rpm. The head on the turbine is 30 m. if the head on the turbine reduced to 18m, determine the speed and power developed by the turbine.	Understand	AME008.16
9	a) Explain the terms; i. Cavitation and ii. Water hammer b) A Kaplan turbine develops 24647.6 KW power at an average head of 39 m. assuming speed ratio of 2, flow ratio of 0.6, diameter of the boss = 0.35 x diameter of the runner and an overall efficiency of 90%. Calculate the diameter, speed and specific speed of the turbine.	Remember	AME008.13
10	a) Derive an expression for specific speed of a turbine. b) A Francis turbine with an overall efficiency of 75% is required to produce 148.25 KW power. It is working under a head of 7.62 m. the peripheral velocity = $0.26\sqrt{(2gH)}$ and the radial velocity of flow at inlet is $0.96\sqrt{(2gH)}$. The wheel runs at 150 rpm and the hydraulic losses in the turbine are 22% of the available energy. Assuming radial discharge determine; i. The guide blade angle, ii. The wheel vane angle at inlet and iii. Diameter of the wheel at inlet.	Understand	AME008.14

UNIT-V

CENTRIFUGAL PUMPS AND RECIPROCATING PUMPS

Part - A (Short Answer Questions)

S No	QUESTION	Blooms Taxonomy Level	Course Learning Outcomes
1	What is the function of pump?	Understand	AME008.17
2	Draw the neat diagram of centrifugal pump.	Remember	AME008.18
3	What is static head?	Understand	AME008.19
4	What is Manometric head?	Remember	AME008.20
5	Define specific speed for centrifugal pump?	Understand	AME008.21
6	Draw the O.C curves for centrifugal pump.	Remember	AME008.17

7	Draw the Muschel curves for centrifugal pump.	Understand	AME008.18
8	How cavitation occurs in centrifugal pumps.	Remember	AME008.19
9	What water hammer?	Understand	AME008.20
10	What is NPSH?	Remember	AME008.21
11	Name different efficiency of centrifugal pump	Understand	AME008.17
12	What are the functions of multistage centrifugal pump?	Remember	AME008.18
13	Define priming of centrifugal pump.	Understand	AME008.19
14	How can you prevent cavitations?	Understand	AME008.20
15	Write expression for Thomas cavitation factor	Remember	AME008.21
16	Define slip of reciprocating pump	Understand	AME008.17
17	What is meant by indicator diagram?	Remember	AME008.18
18	Write an expression for work done by reciprocating pump	Understand	AME008.19
19	Define suction head and delivery head	Remember	AME008.18
20	Draw constant efficiency curves for centrifugal pump	Understand	AME008.19
Part - B (Long Answer Questions)			
1	A centrifugal pump is to discharge 0.118 m^3/s at a speed of 1450 rpm against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller.	Understand	AME008.17
2	The diameter of an impeller of a centrifugal pump at inlet and outlet are 30 cm and 60 cm respectively. Determine the minimum starting speed of the pump, if it works against a head of 30 m.	Remember	AME008.18
3	Derive an expression specific speed of a centrifugal pump.	Understand	AME008.19
4	Draw and explain characteristic curves for centrifugal pumps.	Remember	AME008.20
5	What will happen when the pumps are connected in series and parallel?	Understand	AME008.21
6	What is Cavitation Explain how it is detected. What are the effects of Cavitation. Explain how cavitation can be avoided.	Remember	AME008.17
7	A centrifugal pump having an overall efficiency of 80% delivers 1850 liters of water per minute to a height of 20 meters through a pipe of 100mm diameter and 95 meters length. Taking f=0.0075, find the power required to drive the pump.	Understand	AME008.18
8	Draw and explain centrifugal pump working with neat sketch.	Remember	AME008.19
9	Explain different efficiencies of centrifugal pump.	Understand	AME008.20
10	How number of vanes effects head and efficiency of a centrifugal pump.	Remember	AME008.21
11	A centrifugal pump is to discharge 0.118 m^3/s at a speed of 1450 rpm against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller.	Understand	AME008.17
12	The diameter of an impeller of a centrifugal pump at inlet and outlet are 30 cm and 60 cm respectively. Determine the minimum starting speed of the pump, if it works against a head of 30 m.	Remember	AME008.18
13	Derive an expression specific speed of a centrifugal pump.	Understand	AME008.17
14	Draw and explain characteristic curves for centrifugal pumps.	Remember	AME008.18

15	What will happen when the pumps are connected in series and parallel?	Understand	AME008.19
16	What is Cavitation? Explain how it is detected and how cavitation can be avoided.	Remember	AME008.20
17	A centrifugal pump having an overall efficiency of 80% delivers 1850 liters of water per minute to a height of 20 meters through a pipe of 100mm diameter and 95 meters length. Taking f=0.0075, find the power required to drive the pump.	Remember	AME008.21
18	Draw and explain centrifugal pump working with neat sketch.	Understand	AME008.17
19	Explain different efficiencies of centrifugal pump.	Remember	AME008.18
20	How number of vanes effects head and efficiency of a centrifugal pump.	Understand	AME008.18
Part – C (Problem Solving and Critical Thinking)			
1	a) What is the necessity of priming in centrifugal pumps? b) A centrifugal pump is to discharge 0.118 m^3/s at a speed of 1450 rpm against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller.	Understand	AME008.17
2	a) Give the classification of centrifugal pumps. b) A centrifugal pump delivers water against a net head of 14.5 m and a design speed of 1000 rpm. The vanes are curved back to an angle of 30^0 with the periphery. The impeller diameter is 300 mm and outlet width 50 mm. determine the discharge of the pump if manometric efficiency 95%.	Remember	AME008.18
3	a) Differentiate between centrifugal and reciprocating pumps. b) The diameter of an impeller of a centrifugal pump at inlet and outlet are 30 cm and 60 cm respectively. Determine the minimum starting speed of the pump, if it works against a head of 30 m.	Understand	AME008.19
4	a) Define NPSH in pumps. b) The diameters 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 m/s and the vanes are set back at angle of 45^0 at the outlet. Determine the minimum starting speed of the pump, if the manometric efficiency is 70%.	Remember	AME008.20
5	a) Explain the importance of multistage centrifugal pump. b) A four stage centrifugal pump has four identical impellers keyed to the same shaft. The shaft is running at 400 rpm and the total manometric head developed by the multistage pump is 40 m. The discharge through the pump is 0.2 m^3/s. the vanes of each impeller are having outlet angle as45^0. If the width and diameter of each impeller at outlet is 5 cm and 6 cm respectively. Calculate the manometric efficiency.	Understand	AME008.21
6	a) Explain the working of a reciprocating pump with a neat sketch. b) A double acting reciprocating pump running at 40 rpm is discharging 1 m^3 of water per minute. The pump has a stroke of 400 mm. the diameter of the piston is 200 mm. the delivery and suction heads are 20 m and 5 m respectively. Determine the slip of the pump and the power required to drive the pump.	Remember	AME008.17

7	a) What is the function of an air vessel in reciprocating pumps? b) A single stage centrifugal pump with impeller diameter of 30 cm rotates at 2000 rpm and lifts 3 m^3 of water per second to a height of 30 m with an efficiency of 75%. Calculate the no. of stages and diameter of each impeller of a similar multistage pump to lift 5 m^3 of water per second to a height of 200 m when rotating at 1500 rpm.	Understand	AME008.18
8	a) Determine the number of pumps required to take water from a deep well under a total head of 89 m all the pumps are identical and running at 800 rpm. The specific speed of each pump is given as 25 while the rated capacity of each pump is 0.16 m^3/s. b) Draw and explain characteristic curves of centrifugal pumps.	Remember	AME008.19
9	a) Derive an expression for work done by the centrifugal pump. b) A single-acting reciprocating pump running at 30 r.p.m., delivers 0.012 m^3/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.	Understand	AME008.20
10	a) Define the following; i. Manometric efficiency ii. Mechanical efficiency and iii. Overall efficiency. b) A single-acting reciprocating pump has a plunger of diameter 250 mm and stroke of 350 mm. if the speed of the pump is 60 rpm and it deliver 16.5 lps of water against a suction head of 5 m and a delivery head of 20 m. Determine the theoretical discharge, coefficient of discharge, the slip, the percentage of slip and the power required to drive the pump.	Remember	AME008.21

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