INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**MECHANICS OF FLUIDS**
Course Code	:	A30101
Class	:	II B. Tech I Semester
Branch	:	Aeronautical
Year	:	2016– 2017
Course Coordinator	:	Mr.C.Satya Sandeep Assistant Professor
Course Faculty	:	Mr.C.Satya Sandeep Assistant Professor

OBJECTIVES

The objectives of the course are to enable the student;

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

S No	QUESTION	Blooms taxonomy level	Course Outcome
	UNIT-I DIMENSIONS AND UNITS		
Part –A (Short Answer Questions)			
1	Define density, weight density.	Understanding	1
2	Define specific volume and specific gravity.	Understanding	1
3	Define Newton's laws of viscosity.	Understanding	1
4	Define surface tension.	Understanding	1
5	Define compressibility.	Understanding	1
6	Define viscosity.	Understanding	1
7	Define vapor pressure.	Understanding	1
8	Define atmospheric gauge and vacuum pressure.	Understanding	1
9	Define compressible and incompressible fluid.	Understanding	1
10	Define and classify the manometers.	Understanding	1
Part-B (Long Answer Questions)			
1	Explain Newton's law of viscosity and derive an expression for coefficient of viscosity.	Explain	2
2	What is surface tension? Derive an expression for surface tension on a water droplet and a bubble.	Explain	2
3	Explain capillarity and derive an expression for capillary rise and fall.	Apply	3

4	Derive an expression for calculating pressure difference in differential manometer.	Apply	2
5	Derive an expression for calculating pressure at a point using simple manometer.	Derive	3
6	Derive an expression for calculating metacentric height and explain metacenter and metacentric height.	Derive	2
7	Define density, weight density, specific gravity and specific volume of a fluid.	Define	3
8	Discuss about the change in viscosity for gases and liquids with the increase of temperature.	Discuss	2
9	Explain absolute gauge and vacuum pressures.	Explain	2
10	Define compressibility and bulk modulus of elasticity. Explain its units.	Define	2
Part-C (Critical Answer Type Questions)			
1	A plate of a certain oil weighs 40 KN. Calculate the specific weight, mass density and specific gravity of this oil.	Apply	1
2	A plate 0.0254 mm distant from a fixed plate, moves at 61cm/sec and requires a force of 0.2 kgf/m^2 to maintain this speed. Determine the dynamic viscosity of the fluid between the plates.	Apply	1
3	A rectangular plate of size 25 cm by 50 cm and weighing 25 kgf slides down a 30^0 inclined surface at a uniform velocity of 2m/sec. If the uniform 2mm gap between the plate and the inclined surface is filled with oil determine the viscosity of the oil.	Apply	1
4	Calculate the capillary effect in mm in a glass tube 3mm in diameter when immersed in (a) water (b) mercury. Both the liquids are at 20^{0}c and the values of the surface tensions for water and mercury at 20^{0}c in contact with air are respectively 0.0736 N/m and 0.51 N/m. Contact angle for water = 0^0 and for mercury = 130^0.	evaluate	1
5	What is the pressure within a droplet of water 0.05 mm in diameter at 20^{0}c, if the pressure outside the droplet is standard atmospheric pressure of 1.03 kg (f) / cm^2. Given σ = 0.0075 kg (f)/m for water at 20^0 C.	evaluate	1
6	A hydraulic press has a ram of 30 cm diameter and a plunger of 4.5 cm diameter. Find the weight lifted by the hydraulic press when the force applied at the plunger is 500N.	Apply	1
7	Calculate density, specific weight and weight of 1 liter of petrol of specific gravity 0.7	Apply	1
8	A u-tube manometer is used to measure pressure in a pipe line, Which is in excess with the atmospheric pressure, the right limb of the manometer contains mercury and is open to water in the mainline, if the difference in the level of mercury in the limbs of u tube is 10 cm and the free surface of the mercury is in the level with the center of the pipe. If the pressure of water in the pipeline is reduced to 9810 N/m.sq, calculate the new difference for the level of mercury, Sketch the arrangement in both cases.	Apply	1
9	An inverted u-tube manometer is connected to 2 horizontal pipes A and B through which water is flowing. The vertical distance between the axes of these pipes is 30 cm. When an oil of specific gravity 0.8 is used as a gauge fluid, the vertical heights of the water columns in the 2 limbs of inverted manometer (when measured from the respective center lines of the pipes) are found to be same equal to 35 cm. Determine the difference of pressure between the pipes.	Apply	1
10	Find the density of a metallic body which floats at the interface of mercury of specific gravity 13.6 and water, such that 40% of each volume is submerged in mercury and 60% in water.	Apply	1

UNIT-II FLUID KINEMATICS			
Part – A (Short Answer Questions)			
1	Define path line, streamline, stream tube and streak line.	Understanding	4
2	Define steady and unsteady flows.	Understanding	4
3	Define rotational and irrotational flows.	Understanding	4
4	Define uniform and non-uniform flows.	Understanding	5
5	Define and state the applications of momentum equation.	Understanding	5
6	Define laminar and turbulent flows.	Understanding	4
7	Define compressible and incompressible flows.	Understanding	5
8	Define the equation of continuity.	Understanding	4
9	Define the terms velocity potential and stream functions.	Understanding	5
10	Define the terms vertex, free vortex flows and forced vortex flows.	Understanding	5
Part - B (Long Answer Questions)			
1	Sketch the flow pattern of an ideal fluid past a cylinder with circulation.	Understanding	4
2	Derive the condition for irrotational flow. Prove that for potential flow, both the stream function and velocity potential function must satisfy Laplace equation.	Understanding	4
3	Derive an expression for total pressure on a plane surface submerged in a liquid of specific weight with an inclination an angle θ.	Understanding	4
4	Obtain an expression for continuity equation for a 3-D Flow.	Apply	4
5	Bring out the mathematical and physical distinction between rotational and irrotational flows.	Apply	4
6	Describe the use and limitations of flow nets	Analyze	4
7	Obtain an expression for continuity equation for a 1-D Flow	Analyze	4
8	Define path line, stream line, and streak line.	Analyze	4
9	State the properties of stream function and prove each one of them.	Analyze	4
10	What is a stream tube and explain are its characteristics.	Analyze	4
Part – C (Problem Solving and Critical Thinking)			
1	Give a practical example of laminar flow, turbulent flow steady flow and uniform flow.	Analyze	
2	Explain vortex flow, free vortex flow and forced vortex flows.	Analyze	
3	Differentiate between rotational and irrotational flow and give example for each.	Differentiate	
4	Sketch an example of 1-D flow	Analyze	
5	An open circular cylinder of 15cm diameter and 100cm long contains water up to a height of 70cm.find the speed at which the cylinder is to be rotated about its vertical axis so that the axial depth becomes zero.	Apply & evaluate	2
6	A vessel cylindrical in shape and closed at the bottom contains water up to a height of 80cm.the diameter of the vessel is 20cm and length of vessel is 120cm. the vessel is rotated at a speed of 400r.p.m about its vertical axis. Find the height of parabolic formed.	Apply & evaluate	2
7	In a free cylindrical vortex flows at a point in the fluid at a radius of 200mm and a height of 100mm.The velocity and pressures are 10m/s and 117.72KN/m^2.find the pressure at a radius of 400mm and at a height of 200mm. the fluid is air having density equal to 1.24kg/m^3.	Apply & evaluate	3
8	An open circular cylinder of 20cm dia and 100cm long contains water up to a height of 80cm. It is rotated about its vertical axis. Find the speed of rotation when there is no water spills and axial depth is Zero.	Apply & evaluate	2
9	In a free cylindrical vortex flow of water at a point at a radius of 150mm the velocity and pressure are 5m/s and 14.715n/cm^2. Find the pressure at a radius of 300mm.	Apply & evaluate	2
10	If the cylindrical vessel of dia 15cm and length 100cm contains water at a height of 80cm is rotated at 950r.p.m. About its vertical axis, find the Area uncovered at the base of the tank.	Apply & evaluate	2

UNIT-III FLUID DYNAMICS			
Part - A (Short Answer Questions)			
1	Name the different forces present in a fluid flow.	Understanding	7
2	What is Euler's equation of motion?	Understanding	7
3	What is ventuimeter?	Understanding	7
4	Define an orifice meter.	Understanding	7
5	What is a pitot tube?	Understanding	7
6	Define moment of momentum equation.	Understanding	7
7	Define continuity and Bernoulli's equation.	Remembering	7
8	What is a free jet of a liquid?	Understanding	7
9	What are the different forms of energy in a flowing fluid?	Understanding	7
10	Explain different types of pivot tubes	Understanding	7
Part – B (Long Answer Questions)			
1	Derive an expression for displacement thickness due to formation of boundary layer	Understanding	9
2	How do you distinguish sharp crested weir from a broad crested weir? Derive the expression for discharge over a sharp crested rectangular weir?	Apply	9
3	For the Euler's equation of motion which forces are taken into consideration?	Apply	9
4	What is Euler's equation? How will you obtain Bernoulli's equation from it?	Apply	9
5	Discuss the relative merits and demerits of ventuimeter with respect to orifice meter.	Apply	5
6	What is the difference between the pivot tube and pivot static tube.	Apply	5
7	What is the difference between the momentum equation and impulse momentum equation?	Apply	5
8	Derive Euler's equation of motion along a stream line for an ideal fluid and clearly the assumptions.	Apply	5
9	Why is divergence more gradual than convergence in a ventuimeter?	Apply	5
10	Explain the principle of ventuimeter with a neat sketch. Derive the expression rate of flow of fluid through it.	Apply	5
Part – C (Problem Solving and Critical Thinking)			
1	When 2500 liters of water flows per minute through a 0.3m diameter pipe which later reduces to a 0.15 diameter pipe, calculate the velocities of flow in the two pipes.	Apply & evaluate	6
2	A pipe of dia 400mm carries water at a velocity of 25m/s. The pressures at a point are given as 29.43n/cm^2 and 22.563n/cm^2 while the datum head at A and B are 28m and 30m. Find the loss of head between A and B.	Apply & evaluate	6
3	A horizontal ventuimeter with inlet and throat and diameters 30cm and 15cm is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20cm of mercury. Determine the rate of flow. Take $C_d = 0.98$.	Apply & evaluate	5
4	Two velocity components are given in the following case, find the third component such that they satisfy the continuity equation. $U= x^3 + y^2+2z^2$ $V= -x^2y- yz –xy$	Apply & evaluate	6
5	The velocity components in a two-dimensional flow field for an incompressible fluid are expressed as $U= y^3/3 + 2x-x^2y$ $v= xy^2-2y-x^3/3$. a) Show that these functions represent a possible case of an ir-rotational flow. b) Obtain an expression for stream function Ψ c) Obtain an expression for velocity potential Φ	Apply & evaluate	4
6	For a three-dimensional flow field described by V = (y^2+z^2): + (x^2+z^2)j +	Apply &	6

	$(x^2+y^2)k$ find at (1,2,3). (i) the component of acceleration (ii) the components of rotation	evaluate	
7	In a straight uniform pipe, the discharge is reduced from 0.1 m^3/s to zero in 10 seconds. If the cross-sectional area of the pipe is 200 sq. cm, state the nature and value of acceleration.	Apply & evaluate	4
8	A nozzle is so shaped that the velocity of flow along the centerline changes linearly from 1-5 m/s to 15 m/s in a distance of 0.375. Determine the magnitude of the convective acceleration at the beginning and end of this distance.	Apply & evaluate	5
9	In a 100mm dia horizontal pipe a ventuimeter of 0.5 contraction ratio has been fixed the head of water on the meter when there is no flow is 3m. Find the rate of flow for which the throat pressure will be 2m of water absolute. Take atmospheric pressure head= 10.3m of water. The coefficient of meter is 0.97.	Apply & evaluate	6
10	For a two-dimensional flow $\Phi = 3xy$ and $x = 3/2\ (y^2-x^2)$. Determine the velocity components at the points (1, 3) and (3, 3). Also find the discharge passing between the streamlines passing through the points given above.	Apply & evaluate	6
UNIT-IV **BOUNDARY LAYER THEORY**			
Part - A (Short Answer Questions)			
1	What do you understand by the terms boundary layer theory.	Understanding	9
2	What is meant by boundary layer?	Understanding	9
3	What do you mean by boundary layer separation?	Remembering	9
4	Define displacement thickness.	Remembering	9
5	What are the different methods of preventing the separation of boundary layers?	Understanding	9
6	What is the effect of pressure gradient on boundary layer separation.	Remembering	9
7	Define laminar boundary layer and turbulent boundary layer.	Understanding	9
8	Define laminar sub layer and boundary layer thickness.	Understanding	9
9	Define the terms drag, lift and momentum thickness.	Understanding	9
10	Define Magnus effect.	Understanding	9
Part - B (Long Answer Questions)			
1	Derive an expression for displacement thickness due to formation of boundary layer.	Apply	9
2	Derive an expression for energy thickness of boundary layer.	Apply	9
3	Derive an expression for momentum thickness of boundary layer.	Apply	9
4	Define laminar turbulent and laminar sub layer in boundary layer theory.	Apply	9
5	Define and Explain the length of the boundary layer.	Apply	9
6	What are the boundary conditions that must be satisfied by a given velocity profile in laminar boundary layer flows.	Understanding	9
7	Obtain Von Karman momentum integral equation.	Understanding	9
8	Explain boundary layer separation? Mention few methods to prevent or delay the separation of boundary layer?	Evaluate	9
9	Derive Prandtl's boundary layer equation.	Evaluate	9
10	Explain and derive expression for lift and drag.	Explain	9
Part – C (Problem Solving and Critical Thinking)			
1	A plate of 600mm length and 400mm wide is immersed in a fluid of specific gravity 0.9 and kinematic viscosity $v=10^{-4}m^{2/s}$. The fluid is moving with a velocity of 6m/s. determine boundary layer thickness, shear stress at the end of the plate and drag force one side of the plate.	Apply	6
2	Air flows at 10m/s past a smooth rectangular flat plate 0.3m wide and 3m long. Assuming that's the turbulence level in the oncoming stream is low and that transition occurs at $R_e=5\ X\ 10^5$, Calculate ratio of total drag when	Apply	6

	the flow is parallel to the length of the plate to the value when the flow is parallel to the width.		
3	Oil with a free stream velocity of 2m/s flows over a thin plate 2m wide and 2m long. Calculate the boundary layer thickness and the shear stress at the trailing end point and determine the total surface resistance of the plate. Take specific gravity 0.86 and kinematic viscosity 10^{-5} m^2/s.	Apply	3
4	A thin plate is moving in still atmospheric air at a velocity of 4m/s. The length of plate is 0.5m and width is 0.4m, calculate the thickness of boundary layer at the end of the plate and the drag force on one side of the plate. Take density of air is 1.25kg/m^3 and kinematic viscosity 0.15 stokes.	Apply	4
5	A smooth flat plate of size 30 cm X 60 cm is placed in a stream of water of uniform velocity 60 cm/sec. Flow takes parallel to the 30 cm length of the plate. If the kinematic viscosity of water is 0.011 stoke, is the boundary layer formed on the plate laminar or turbulent? Determine the shear stress at the trailing edge, maximum boundary layer thickness, mean drag coefficient and the work done by the fluid on one side of the plate per unit time in Joules.	Apply	4
6	A stream lined train is 350 m long and has an average cross-section with a perimeter of 110.2 m above the wheels. Assuming that the boundary layer is completely turbulent, compute the surface drag for a speed of 120 mph and power required to overcome this drag. Dynamic viscosity of air = 0.000185 poise and specific weight = 12 N/m^3.	Apply	9
7	A smooth flat plate of size 6 m by 3m is towed in a liquid of density 900kg/ m^3 and viscosity 0.12 poises at a uniform velocity of 2.5 m/s. The motion is parallel to the 6 m side of the plate. What is the length of the plate over which the boundary layer is laminar? Calculate the surface drag on both sides of plate.	Apply	9
8	Write a short notes on the separation of the boundary layer.	Apply	
9	Differentiate between and energy and momentum thickness of the boundary layer.	Discuss	9
10	Discuss the two forces applied on a flowing fluid.	Discuss	10
UNIT-V **FLOW THROUGH PIPES**			
Part - A (Short Answer Questions)			
1	Define Reynolds's experiment.	Understanding	10
2	What are the characteristics of laminar flows?	Remembering	10
3	What are the characteristics of laminar flows?	Remembering	10
4	What is the flow between parallel lines?	Remembering	11
5	What are the laws of fluid friction?	Understanding	11
6	Define Darcy's equation.	Understanding	11
7	What are minor losses in pipes in series?	Understanding	10
8	What are minor losses in pipes in parallel?	Understanding	11
9	What is energy line?	Remembering	11
10	What is hydraulic gradient line?	Understanding	11
Part - B (Long Answer Questions)			
1	Obtain the condition for maximum efficiency in transmission of power through pipeline	Apply	11
2	Derive formulas for hydraulic gradient and total energy lines	Apply	11
3	Derive the equation for head loss in pipes due to friction Darcy-Weisbach equation.	Apply	10
4	What are the minor losses in pipes? Give the appropriate formulae to calculate the losses.	Apply	11
5	What do you understand by turbulent flow? What factor decides the type of flow in pipes?	Apply	11
6	Derive an expression for the loss of head due to friction in pipes.	Apply	11

7	Derive Darcy-Weisbach equation.	Apply	10
8	What is the velocity defect? Derive an expression for velocity defect in pipes?	Apply	11
9	Why are the pipes connected in parallel?	Apply	11
10	Explain what you understand by hydraulic grade line and total energy line. Discuss its practical significance in analysis of fluid flow problems.	Apply	11
Part – C (Problem Solving and Critical Thinking)			
1	Determine the distance from the pipe wall at which the local velocity is equal to the average velocity for turbulent flow in pipes.	Evaluate	9
2	A smooth pipe of diameter 400mm and length 800mm carries water at the rate of 0.04m^3/s. determine the head lost due to friction, wall shear stress, center line velocity and thickness of laminar sub layer. Take kinematic viscosity of water as 0.018 stokes.	Evaluate	9
3	Water is flowing through a rough pipe of diameter 600mm at the rate 600liters/sec. the wall roughness is 3mm. find the power lost for 1km length of pipe.	Evaluate	9
4	A 0.3m diameter pipe 2340m long is connected with a reservoir whose surface is 72m above the discharging end of the pipe. If for the last 1170m, a second pipe of the same diameter be laid beside the first and connected to it. What would be the increase in the discharge? Take f=0.02	Evaluate	9
5	A compound piping system consists of 1800m of 0.50m, 1200m of 0.40m and 600m of 0.30m new cast iron pipes connected in series. Convert the system to (a) an equivalent length of 0.40m pipe and **(b)** Equivalent size pipe 3600m long.	Evaluate	10
6	A pipe having a length of 6km and diameter 0.70m connects two reservoirs A and B, the difference between their water levels is 30m. Half way along the pipe there is a branch through which water can be supplied to a third reservoir C. Taking f = 0.024 determine the rate of flow of reservoir B when a) no water is discharged to reservoir C b) The quantity of water discharged to reservoir C is 0.15 m^3/s neglect minor losses.	Evaluate	9
7	A pipeline 0.225 m in diameter and 1580m long has a slope of 1 in 200 for the first 790m and 1 in 100 for the next 790m. The pressure at the upper end of the pipeline is 107.91 kpa and at the lower end is 53.955 kpa. Taking f=0.032 determine the discharge through the pipe.	Evaluate	9
8	The velocities of water through a pipe of diameter 10cm are 4m/s and 3.5m/s at the center of the pipe and 2cm from the pipe center. Determine the wall shearing stress in the pipe for turbulent flow.	Evaluate	9
9	Determine the average height of the roughness for a rough pipe of diameter 10cm when the velocity at a point 4cm from wall is 40% more than the velocity at a point 1cm from pipe wall.	Evaluate	10
10	For turbulent flow in a pipe diameter 300mm, find the discharge when the center line velocity is 2m/s and the velocity at a point 100mm from the center as measured by pivot tube is 1.6m/s.	Evaluate	12

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