SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR

(AUTONOMOUS)

Siddharth Nagar, Narayanavanam Road–517583

QUESTION BANK (DESCRIPTIVE)

Subject: Hydraulics and Hydraulic Machinery (23CE0114) Course & Branch: B.Tech & Civil

Year & Sem: II-B.Tech –II Sem Regulation: R23

UNIT–I

LAMINAR AND TURBULENT FLOW IN PIPES

1	a) Define laminar flow and what is the value of Reynolds number	**[L1] [CO1]**	**[2M]**
	b) State Stoke's law	**[L1] [CO1]**	**[2M]**
	c) What is the aim of Reynolds experiment	**[L1] [CO1]**	**[2M]**
	d) Differentiate smooth and rough pipe	**[L2] [CO1]**	**[2M]**
	e) Define boundary layer thickness	**[L1] [CO1]**	**[2M]**
2	a) Differentiate laminar and turbulent flow	**[L2] [CO1]**	**[5M]**
	b) An oil of viscosity 9 poise and specific gravity 0.9 is flowing through a horizontal pipe of 60 mm diameter. If the pressure drop in 100 m length of the pipe is 1800 kN/m^2, determine rate of flow of oil, centre line velocity, total frictional drag over 100 m length, power required to maintain the flow, velocity gradient at the pipe wall and velocity and shear stress at 8 mm from the wall.	**[L4] [CO1]**	**[5M]**
2	a) List out the characteristics of laminar flow and give examples for laminar flow	**[L1] [CO1]**	**[5M]**
	b) Oil of absolute viscosity 1.5 poise and density 848.3 kg/m^3 flow through a 30 cm diameter pipe. If the head loss in 3000 m length of a pipe is 20 m. Assuming laminar flow, determine the velocity, Reynolds number and friction factor	**[L4] [CO1]**	**[5M]**
4	Derive an expression for laminar flow through circular pipes	**[L2] [CO1]**	**[10M]**
5	a) Discuss flow of viscous fluid through an annulus	**[L1] [CO1]**	**[5M]**
	b) A crude oil of viscosity 0.9 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 120 mm and length 1.2 m. Calculate the difference of pressure at the two ends of the pipe if 785 N of the oil is collected in a tank in 25 seconds.	**[L4] [CO1]**	**[5M]**
6	a) Explain flow of viscous fluid between two parallel plates when one plate is moving and other at rest	**[L1] [CO1]**	**[5M]**
	b) A liquid with a specific gravity 2.8 and a viscosity 0.8 poise flows through a smooth pipe of unknown diameter, resulting in a pressure drop of 800 N/m^2 in 2 km length of the pipe. What is the pipe diameter if the mass flow rate is 2500 kg/h.	**[L4] [CO1]**	**[5M]**
7	Derive Navier – Stokes equations of motion.	**[L2] [CO1]**	**[10M]**
8	a) Explain flow of viscous fluid between two parallel plates when both plates at rest	**[L1] [CO1]**	**[5M]**
	b) Oil of specific gravity 0.82 is pumped through a horizontal pipeline 150 mm in diameter and 3 km long at the rate of 0.015 cumec. The pump has an efficiency of 68% and requires 7.5 kW to pump the oil. What is the dynamic viscosity of the oil and is the flow is laminar.	**[L4] [CO1]**	**[5M]**
9	a) Describe briefly any two methods of determining the coefficient of viscosity of a liquid	**[L1] [CO1]**	**[5M]**
	b) Two parallel plates kept 100 mm apart have laminar flow of oil between them with a maximum velocity of 1.5 m/s. Calculate discharge per meter width, shear stress at the plates, difference of pressure between two points 20 m apart, velocity gradient at the plates and velocity at 20 mm from the plate. Assume viscosity of oil to be 24.5 poise.	**[L4] [CO1]**	**[5M]**

10	a) Explain Reynolds experiment with a neat sketch	**[L1] [CO1]**	**[5M]**
	b) The viscosity of an oil of specific gravity 0.8 is measured by a capillary tube of diameter 40 mm. The difference of pressure head between two points 1.2 m apart is 0.3 m of water. The weight of oil collected in a measuring tank is 400 N in 100 seconds. Find the viscosity of oil.	**[L4] [CO1]**	**[5M]**
11	a) Sketch and discuss about Moody's diagram	**[L1] [CO1]**	**[5M]**
	b) Define boundary layer and explain the characteristics of boundary layer.	**[L1] [CO1]**	**[5M]**

UNIT–II

UNIFORM FLOW IN OPEN CHANNELS

1	a) Differentiate uniform flow and non uniform flow	**[L2] [CO2]**	**[2M]**
	b) Define prismatic channel	**[L1] [CO2]**	**[2M]**
	c) What is open channel flow?	**[L1] [CO2]**	**[2M]**
	d) Define economical section	**[L1] [CO2]**	**[2M]**
	e) State the conditions for most economical trapezoidal section	**[L1] [CO2]**	**[2M]**
2	a) Compare open channel flow and pipe flow	**[L2] [CO2]**	**[5M]**
	b) Find the rate of flow and conveyance for a rectangular channel 7.5 m wide for uniform flow at a depth of 2.25 m. The channel is having bed slope as 1 in 1000. Take Chezy's constant as 55.	**[L4] [CO2]**	**[5M]**
3	a) List various types of channels and explain briefly	**[L1] [CO2]**	**[5M]**
	b) A triangular gutter whose sides include an angle of 60 degrees conveys water at a uniform depth of 250 mm. If the discharge is 0.04 cumec, determine the gradient of the trough. Take C = 52	**[L4] [CO2]**	**[5M]**
4	a) Classify various types of flow in channels and explain	**[L2] [CO2]**	**[5M]**
	b) Find the discharge of water through the circular channel of diameter of 1.2 m. Take the value of C = 60 and slope of the bed as 1 in 950	**[L4] [CO2]**	**[5M]**
5	a) What are the different geometrical properties of a open channel.	**[L1] [CO2]**	**[5M]**
	b) A canal of trapezoidal section has bed width of 8 m and bed slope of 1 in 4000. If the depth of flow is 2.4 m and side slopes of the channel are 1 horizontal to 3 vertical, determine the average flow velocity and the discharge carried by the channel. Also compute the average shear stress at the channel boundary.	**[L4] [CO2]**	**[5M]**
6	a) Derive an expression for velocity of flow through open channel using Chezy's equation.	**[L1] [CO2]**	**[5M]**
	b) State the following formulae for the value of C: Bazin formula, Kutter formula and Manning formula.	**[L1] [CO2]**	**[5M]**
7	a) Derive the conditions to be most economical rectangular channel section	**[L2] [CO2]**	**[5M]**
	b) Determine the most economical section of rectangular channel carrying water at the rate of 0.5 cumec, the bed slope of the channel being 1 in 2000. Take C = 60.	**[L5] [CO2**	**[5M]**
8	a) Derive the conditions to be most economical trapezoidal channel section	**[L2] [CO2]**	**[5M]**
	b) Design an earthen trapezoidal channel for water having a velocity of 0.6 m/s, side slope of the channel is 1:1.5 and quantity of water flowing is 3 cumec. Assume C as 65	**[L6] [CO2]**	**[5M]**
9	a) Derive the conditions to be most economical triangular channel section	**[L2] [CO2]**	**[5M]**
	b) A trapezoidal channel has side slopes if 3 horizontal to 4 vertical and the slope of its bed is 1 in 2000. Determine the optimum dimensions of the channel, if it is to carry water at 0.5 cumec. Take Chezy's constant as 80.	**[L5] [CO2]**	**[5M]**
10	a) A rectangular channel is to be dug in the rocky portion of a soil. Find its most economical cross-section if it is to convey 12 cumec of water with an average velocity of 3 m/s. Take C = 50.	**[L5] [CO2]**	**[5M]**
	b) Derive an expression for best side slope for most economical trapezoidal channel section.	**[L2] [CO2]**	**[5M]**
11	a) Define and state the formulae of Energy and momentum Correction factors	**[L1] [CO2]**	**[5M]**
	b) Define the following terms: Hydraulic radius, Wetted perimeter and Slope of the bed.	**[L1] [CO2]**	**[5M]**

UNIT–III

NON - UNIFORM FLOW IN OPEN CHANNELS

1	a) Differentiate gradually varied and rapidly varied flow	[L2] [CO3]	[2M]
	b) Define specific energy	[L1] [CO3]	[2M]
	c) Calculate critical depth of a rectangular channel having discharge per unit width is 3cumec/s/m	[L4] [CO3]	[2M]
	d) Enumerate hydraulic jump	[L2] [CO3]	[2M]
	e) List the methods to dissipate the energy of flowing water	[L2] [CO3]	[2M]
2	a) Classify non uniform flow through open channels	[L2] [CO3]	[5M]
	b) A 8 m wide channel conveys 15 m^3/s of water at a depth of 1.2 m. Calculate specific energy of the flowing water, critical depth, critical velocity and minimum specific energy. State whether the flow is subcritical or supercritical based on Froude number.	[L4] [CO3]	[5M]
3	a) Explain specific energy curve with a neat sketch	[L1] [CO3]	[5M]
	b) The specific energy for a 3 m wide channel is to be 3 Nm/N. What would be the maximum possible discharge.	[L4] [CO3]	[5M]
4	a) Derive the relationship between specific energy, critical depth and critical velocity	[L2] [CO3]	[5M]
	b) Water flows at a steady and uniform depth of 2 m in an open channel of rectangular cross section having base width equal to 5 m and laid at a slope of 1 in 1000. It is desired to obtain critical flow in the channel by providing a hump in the bed. Calculate the height of the hump. Consider the value of Manning's rugosity coefficient N = 0.02 for the channel surface.	[L4] [CO3]	[5M]
5	a) Explain measurement of flow of irregular channels.	[L1] [CO3]	[5M]
	b) Explain measurement of velocity using suitable methods	[L1] [CO3]	[5M]
6	a) List various assumptions and derive equation of gradually varied flow.	[L1] [CO3]	[5M]
	b) In a rectangular channel 12 m wide and 3.6 m deep water is flowing with a velocity of 1.2 m/s. The bed slope of the channel is 1 in 4000. If flow of water through the channel is regulated in such a way that energy line is having a slope of 0.0004. Find the rate of change of depth of water in the channel.	[L4] [CO3]	[5M]
7	a) In a rectangular channel of width 24 m and depth of flow 6 m, the rate of flow of water is 86.4 m^3/s. If the bed slope of the channel is 1 in 4000, find the slope of the free water surface. Take C = 60.	[L4] [CO3]	[5M]
	b) Explain back water curve and afflux with a neat sketch	[L2] [CO3]	[5M]
8	List various assumptions made in the analysis of hydraulic jump and establish the relationship for depth of jump before and after the hydraulic jump.	[L2] [CO4]	[10M]
9	a) Derive an expression for loss of energy for a hydraulic jump	[L2] [CO4]	[5M]
	b) A sluice gate discharges water into horizontal rectangular channel with a velocity of 10 m/s and depth of flow of 1 m. Determine the depth of flow of water after the jump and consequent loss in total head.	[L4] [CO4]	[5M]
10	a) From the first principles express the depth of flow after the jump in terms of Froude number	[L2] [CO4]	[5M]
	b) A 3.6 m wide rectangular channel conveys 9 cumec of water with a velocity of 6 m/s. Is there a condition for hydraulic jump to occur. If so, calculate the height, length and strength of the jump. What is loss of energy per kg of water.	[L4] [CO4]	[5M]
11	a) Define specific force, specific depth and critical depth.	[L1] [CO4]	[5M]
	b) In a rectangular channel of 0.5 m width, a hydraulic jump occurs at a point where depth of water flow is 0.15 m and Froude number is 2.5. Determine specific energy, critical and subsequent depths, loss of head and Energy dissipated.	[L4] [CO4]	[5M]

UNIT–IV

IMPACT OF JETS

1	a) Define fluid jet	**[L1] [CO5]**	**[2M]**
	b) State the principle behind impact of jet on vanes	**[L1] [CO5]**	**[2M]**
	c) Calculate the force exerted by the jet on a stationary flat plate held normal to the jet having area of 2 sq.m with a velocity of 3 m/s	**[L4] [CO5]**	**[2M]**
	d) Define turbine	**[L1] [CO5]**	**[2M]**
	e) What is the purpose of draft tube?	**[L1] [CO5]**	**[2M]**
2	a) Derive an expression for force exerted on a stationary flat plate held normal to the jet	**[L2] [CO5]**	**[5M]**
	b) A jet of water 75 mm diameter issues with a velocity of 30 m/s and impinges on a stationary flat plate which destroys its forward motion. Find the force exerted by the jet on the plate and work done.	**[L4] [CO5]**	**[5M]**
3	a) Derive an expression for force exerted on a stationary flat plate held inclined to the jet	**[L2] [CO5]**	**[5M]**
	b) A jet of water strikes with a velocity of 35 m/s a flat plate inclined at 30 degrees with the axis of the jet. If the cross sectional area of the jet is 25 sq cm, determine the force exerted by the jet on the plate, components of the force in the direction normal to the jet and ratio in which the discharge gets divided after striking the plate	**[L4] [CO5]**	**[5M]**
4	a) Derive an expression for force exerted on a stationary curved	**[L2] [CO5]**	**[5M]**
	b) A jet of water of diameter 40 mm moving with a velocity of 30 m/s strikes a curved fixed symmetrical plate at the centre. Find the force exerted by the jet of water in the direction of the jet if the jet is deflected through an angle of 120 degrees at the outlet of the curved plate.	**[L4] [CO5]**	**[5M]**
5	a) Derive an expression for force exerted by the jet on the moving plate held normal to the jet	**[L2] [CO5]**	**[5M]**
	b) A nozzle of 60 mm diameter delivers a stream of water at 24 m/s perpendicular to a plate that moves away from the jet at 6 m/s. Find the force on the plate, work done and efficiency of the jet.	**[L1] [CO5]**	**[5M]**
6	a) Derive an expression for force exerted by the jet on the curved plate when the plate is moving in the direction of jet	**[L2] [CO5]**	**[5M]**
	b) A jet of water of 60 mm diameter strikes a curved vane at its centre with a velocity of 18 m/s. The curved vane is moving with a velocity of 6 m/s in the direction of the jet. The jet is deflected through an angle of 165 degrees. Find thrust on the plate in the direction of jet, power of the jet and efficiency of the jet.	**[L4] [CO5]**	**[5M]**
7	a) Classify turbines	**[L4] [CO5]**	**[5M]**
	b) Explain construction and working of Pelton Wheel with a neat sketch	**[L1] [CO5]**	**[5M]**
8	a) Describe work done and efficiency of a Pelton Wheel	**[L1] [CO5]**	**[5M]**
	b) A Pelton wheel is receiving water from a penstock with a gross head of 510 m. One third of gross head is lost in friction in the penstock. The rate of flow through the nozzle fitted at the end of the penstock is 2.2 cumec. The angle of deflection of the jet is 165 degrees. Determine the power given by water to the runner and hydraulic efficiency of the Pelton Wheel	**[L4] [CO5]**	**[5M]**
9	a) List out various design aspects of Pelton Wheel	**[L2] [CO5]**	**[5M]**
	b) A Pelton wheel is to be designed for the following specifications: Power = 9560 kW, Head = 350 m, Speed = 750 rpm, Overall efficiency = 85%, Jet diameter not to exceed 1/6 th of the wheel diameter. Determine wheel diameter, diameter of the jet and number of jets required. Take coefficient of velocity as 0.985 and speed ratio as 0.45	**[L5] [CO5]**	**[5M]**
10	a) Describe work done and efficiency of a Francis turbine	**[L1] [CO5]**	**[5M]**

	b) A Francis turbine with an overall efficiency of 76% is required to produce 150 kW working under a head of 8 m. The peripheral velocity is 0.25 * sqrt(2gH) and the radial velocity of flow at inlet is 0.95* sqrt(2gH). The wheel runs at 150 rpm and the hydraulic losses in the turbine are 20% of the available energy. Determine guide blade angle, wheel vane angle at inlet, diameter of the wheel at inlet and width of the wheel at inlet.	**[L4] [CO5]**	**[5M]**
11	a) Explain characteristics curves of a turbine with a neat sketch.	**[L1] [CO5]**	**[5M]**
	b) Define cavitation and explain its causes and its effects.	**[L1] [CO5]**	**[5M]**

UNIT–V
PUMPS

1	a) Differentiate pump and turbine	[L2] [CO6]	[2M]
	b) State the purpose of priming	[L1] [CO6]	[2M]
	c) Define specific speed of a pump	[L1] [CO6]	[2M]
	d) Define cavitation	[L1] [CO6]	[2M]
	e) Define multistage centrifugal pump	[L1] [CO6]	[2M]
2	a) Classify pumps	[L2] [CO6]	[5M]
	b) The impeller of a centrifugal pump had an external diameter of 450 mm and internal diameter of 200 mm and it runs at 1440 rpm. Assuming a constant radial flow through the impeller at 2.5 m/s and that the vanes at exit are setback at an angle of 25 degrees. Determine inlet vane angle, the angle of absolute velocity of water at exit and work done per N of water.	[L4] [CO6]	[5M]
3	a) Sketch and explain component parts of a centrifugal pump	[L1] [CO6]	[5M]
	b) A centrifugal pump is to discharge 0.118 cumec 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.	[L4] [CO6]	[5M]
4	a) Explain work done by the centrifugal pump with a neat sketch	[L2] [CO6]	[5M]
	b) The impeller of a centrifugal pump having external and internal diameters 500 mm and 250 mm respectively, width at outlet 50 mm and running at 1200 rpm works against a head of 48 m. The velocity of flow through the impeller is constant and equal to 3.0 m/s. The vanes are set back at an angle of 40 degrees at outlet. Determine inlet vane angle, work done by the impeller on water per second and manometric efficiency.	[L4] [CO6]	[5M]
5	a) List different types of heads of a centrifugal pump	[L1] [CO6]	[5M]
	b) The following data relate to a centrifugal pump: The diameter of the impeller at inlet and outlet = 180 mm and 360 mm respectively, The width of the impeller at inlet and outlet = 144 mm and 72 mm respectively, The rate of flow through the pump = 17.28 lit/s, Vane angle at the outlet = 45 degrees. Find the pressure rise in the impeller.	[L4] [CO6]	[5M]
6	a) Classify losses and efficiencies of a centrifugal pump	[L1] [CO6]	[5M]
	b) A centrifugal pump rotating at 1500 rpm delivers 0.2 cumec at a head of 15 m. Calculate the specific speed and the power. Assume overall efficiency of the pump as 0.68 If this pump were to operate at 900 rpm, what would be the head, discharge and power required for homologous condition.	[L4] [CO6]	[5M]
7	a) Derive an expression for minimum starting speed of a centrifugal pump.	[L2] [CO6]	[5M]
	b) A centrifugal pump impeller has diameters at inlet and outlet as 360 mm and 720 mm respectively. The flow velocity at outlet is 2.4 m/s and the vanes are set back at an angle of 45 degrees at the outlet. If the manometric efficiency is 70 percent, calculate the minimum starting speed of the pump.	[L4] [CO6]	[5M]
8	a) Derive an expression for specific speed of a centrifugal pump	[L2] [CO6]	[5M]
	b) The diameter and width of a centrifugal pump impeller are 300 mm and 60 mm respectively. The pump is delivering 144 litres of liquid per second with a manometric efficiency of 85 percent. The effective outlet vane angle is 30 degrees. If the speed of rotation is 950 rpm, calculate specific speed of the pump.	[L4] [CO6]	[5M]
9	a) Define Net Positive Suction Head (NPHS) with a neat sketch and explain cavitation and its effects.	[L1] [CO6]	[5M]
	b) Tests on a pump model indicate a cavitation parameter 0.1. A homologous unit is to be installed at a location where atmospheric pressure 0.91 bar and vapour pressure 0.035 bar absolute and is to pump water against a head of 25	[L4] [CO6]	[5M]

	m. What is the maximum permissible suction head.		
10	a) Sketch and explain the performance and characteristic curves of a centrifugal pump	**[L2] [CO6]**	**[5M]**
	b) Discuss priming of a centrifugal pump.	**[L1] [CO6]**	**[5M]**
11	a) Explain multistage centrifugal pumps when connected in series and parallel	**[L1] [CO6]**	**[5M]**
	b) List operational difficulties in centrifugal pumps	**[L1] [CO6]**	**[5M]**