INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

QUESTION BANK

Course Name	:	**HYDRAULICS & HYDRAULIC MACHINERY**
Course Code	:	A40111
Class	:	II B. Tech II Semester
Branch	:	Civil Engineering
Year	:	2016– 2017
Course Faculty	:	Dr. Venkata Ramana Gedela, Professor, Civil Department

OBJECTIVES

To introduce students to the basic concepts which used for construction of channels.

I. Understanding the importance of types of flows, types of channels, economical sections, specific energy, hydraulic jump, energy dissipation of an open channel flow.

II. Dimensional analysis, Rayleigh's method and Buckingham's pi theorem.

III. Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes.

IV. Applications to radial flow turbines.

V. Chezy's, Manning's and Bazin formulae for uniform flow.

VI. Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep, horizontal and adverse slopes, surface profiles.

VII. Layout of a typical Hydropower installation, Governing of turbines, surge tanks, unit and specific turbines.

VIII. Centrifugal pumps and their performance.

IX. To enhance the ability of students to apply mathematics and fundamentals of science for solving engineering problems.

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	UNIT - I		
	PART - A (SHORT ANSWER QUESTIONS)		
1	**Define** flow in open channel?	Understand	1
2	**Differentiate** between critical, sub critical and super critical flow in open channel.	Analyze	1
3	**Explain** the terms: i) rapidly varying flow ii) gradually varying flow.	Remember	2
4	**Define** what is meant by economical section of a channel?	Understand	1
5	**Explain** the terms: i) specific energy of a flowing liquid ii) minimum specific energy iii) critical depth iv) critical velocity.	Evaluate	3
6	**Explain** the term hydraulic jump?	Evaluate	3
7	**Define** the terms :i)afflux ii) back water curve	Evaluate	3
8	**Expla**in the terms : mild ,critical ,steep ,horizontal and adverse slopes	Remember	3

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
9	**Define** energy dissipation?	Evaluate	3
10	**Discuss** bazin's formula for uniform flow.	Remember	1
	Part - B (Long Answer Questions)		
1	**Derive** an expression for the discharge through a channel by chezy's formula.	Analyze	1
2	**Derive** the conditions for most economical section of a rectangular channel	analyze	1
3	**Derive** the conditions for the best side slope of the most economical trapezoidal section.	creating	1
4	**Prove** that for a channel of circular section , the depth of flow , d=0.81D D for maximum velocity , and =0.95D for maximum discharge, D=diameter of a circular channel, d= depth of flow.	Apply	1
5	**Derive** an expression for critical depth and critical velocity.	Analyze	2
6	**Derive** the condition for maximum discharge for a given value of specific energy.	Apply	2
7	**Derive** an expression for the depth of hydraulic jump in terms of upstream Froude number.	Creating	3
8	**Applying** momentum equation , to open channel flow , $\frac{2q\ 2}{g} = \frac{y1y2}{(y1+y2)}$, State the assumptions made in the derivations.	Analyze	3
9	**Derive** the differential equation for steady gradually varied flow open channels and list all assumptions?	Apply	3
10	**Prove** that the loss of energy head in a hydraulic jump is equal to $\frac{(d2-d1)3}{4d1d2}$ where d_1 and d_2 are the conjugate depths.	Apply	3
	Part - C (Problem Solving and Critical Thinking Questions)		
1	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 as 1 in 2000.Take Chezy's Constant C=55.	analyze	1
2	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 2.4mts and value of Chezy's Constant,C=50.The slope of the bed of the channel is given 1 in 4000.	analyze	1
3	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.	analyze	1
4	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	Analyze	1
5	Find the diameter of a circular sewer pipe which is laid at aslope of 1 in 8000and carries a discharge of 800 liters/sec when flowing half full. Take the value of Manning's N=0.020	analyze	1
6	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=55 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.	Evaluate	1
7	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 40m^2.Find the dimensions of the section if it is most economical. Determine the discharge of the most economical section if C=50.	Apply	1

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8	**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	Analyze	1
9	The discharge of water through a rectangular channel of width 8mts is 15m3/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.	Apply	2
10	The depth of flow of water at certain section of a rectangular channel of 4mts Width is 0.5mts.The discharge through the channel is $16m^3$/sec. If a hydraulic Jump takes place on downstream side. Find the depth of flow after the jump.	Apply	2
	UNIT – II		
	Part – A (Short Answer Questions)		
1	**Define** the terms dimensional analysis and model analysis.	Remembering	4
2	**Discuss** fundamental derived units ?give examples	Analyze	4
3	**Explain** the term "dimensionally homogeneous equation".	Analyze	4
4	**Enumerate** are the methods of dimensional analysis?	Analyze	4
5	**Define** repeating variables?	Evaluate	4
6	**Define** the terms: i) model ii) proto type iii) model analysis iv) hydraulic similitude.	Understand	4
7	**Explain** dimension less numbers?	Remembering	4
8	**Explain** the terms: i) Geometric similarity ii) kinematic similarity iii) Dynamic similarity.	Remembering	4
9	**Explain** the terms :i)Distorted ii) Undistorted model	Evaluate	4
10	**State** Buckingham's π – theorem.	Remembering	4
	Part - B (Long Answer Questions)		
1	**Describe** the rayleigh's method for dimensional analysis.	apply	4
2	**Explain** the different types of hydraulic similarities that must exist between a proto type and it's model?	evaluate	4
3	**Explain** the different laws on which models are designed for dynamic similarity? Where are they used?	creating	4
4	Prove that ratio of inertia force to viscous force gives the reynold's number?	apply	4
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?	Analyse	4
6	**Explain** the process of model testing of partially sub –merged bodies?	apply	4
7	**Explain** about the scale ratios for distorted models.	analyse	4
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.	Analyse	4
9	**Discuss** the method of selecting repeating variables.	evaluate	4
10	**Explain** the procedure for solving problems by Buckingham's π theorem.	apply	4
	Part – C (Problem Solving and Critical Thinking)		
1	**Determine** the dimensions of the given quantities ;Discharge, Force, Specific Weight ,angular acceleration ,dynamic viscosity ,kinematic viscosity.	Remember	4
2	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	4
3	**Find** an expression for the drag force on smooth sphere of diameter "D" with	Remember	4

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	Uniform velocity "V" in a fluid of density and dynamic viscosity.		
4	Efficiency of a fan depends upon density; dynamic viscosity; angular velocity; Diameter ;discharge. Express efficiency in dimensionless parameters .using Rayleigh's method	Understand	4
5	Efficiency depends upon density ;dynamic viscosity; angular velocity; Diameter discharge. Express in terms of dimensionless parameters using Bunkhingham's Theorem	Apply	4
6	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	4
7	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 3000litres/sec .Tests were conducted on15cm diameter pipe using water at 20^0c.Find the velocity and rate of flow in the Model. Viscosity of water at 20^0c is 0.01 poise.	Apply	4
8	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	4
9	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 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	Apply	4
10	A ship 300 m long moves in a sea water whose density is 1030kg/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 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/m^3.Kinematic viscosity of sea water and air Are 0.012 stokes and 0.018 stokes respectively	Apply	4
	UNIT - III		
	Part – A (Short Answer Questions)		
1.	**Define** the term impact of jets	Understand	5
2.	**Obtain** an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of jet.	Understand	5
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.	evaluate	5
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.	Evaluate	5
5.	**Obtain** an expression for the force excreted by a jet of water on a flat vertical plate moving in the direction of jet	Analyze	5
6.	**Describe** the procedure to draw inlet and out let triangles	Evaluate	5
7.	**Define** momentum principle?	Evaluate	5
8	**Explain** the applications of radial flow turbine?	remember	5
9.	**Discuss** about lay out of typical hydro power installation.	Evaluate	5
10.	**Discuss** about types of efficiencies.	Analyze	5
	Part - B (Long Answer Questions)		
1	**Prove** that the force exerted by a jet of water on an inclined fixed plate in the direction of the jet is given by :	Creating & analyse	5

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	$F_x = \rho a V^2 \sin^2\Theta$ Where a=area of jet , V=velocity of the jet		
2	**Prove** that the force exerted by a jet of water on a fixed semi –circular plate in the direction of jet when the plate strikes the centre of the semi –circular plate is two times the force exerted by the jet on an fixed vertical plate.	Evaluate	5
3	For a curved radial vane , find the work done per second ?	Evaluate	5
4	**Differentiate** between : i) the force exerted by a jet of water on a fixed vertical plate and moving plate , and ii) ii)the force exerted by a jet on a single curved moving plate and series of curved moving plate .	Analyse	5
5	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 / s2.	Evaluate	5
6	**Explain** the force exerted by a jet on stationary inclined flat plate?	Evaluate	5
7	**Explain** the force on the inclined plate moving in the direction of the jet ?	Evaluate	5
8	**Explain** the force on the curved plate when the plate is moving in the direction of jet?	Remembering & Evaluate	5
9	**Explain** the force exerted by a jet of water on an unsymmetrical moving curved plate when jet strikes tangentially at one of the tips ?	Understanding	5
10	**Explain** the force exerted on a series of radial curved vanes?	Understanding	5
	Part – C (Problem Solving and Critical Thinking)		
1	A 7.5 cm diameter jet having a velocity of 30 m /s strikes a flat plate ,the normal of which is inclined at 45^0 to the axis of the jet . Find the normal pressure on the plate : i) When the plate is stationary ii) When the plate is moving with a velocity of 15 m/s and away from the jet and also determine the power and efficiency of the jet when the plate is moving .	Analyze	5
2	A jet of water of diameter of 100mm strikes a curved plate at its center with a velocity of 15m/s .the curved plate is moving with a velocity of 7 m/s in the direction of jet. The jet is deflected trough an angle of 150^0. Assuming the plate smooth fine : (1).force exerted on the plate in the direction of the jet . (2) power of the jet (3) efficiency.	Evaluate	5
3	A jet of water having a velocity of 30 m/s strikes a curved vane, which is moving with a velocity of 15 m/s. the jet makes an angle of 30^0 with the direction of motion of vane at inlet and leaves at an angle of 120^0 to the direction of vane at outlet. Calculate : 1) Vane angles , if the water enters and leaves the vane with out shock, 2) Work done per second per unit weight of water striking the vanes per second	Evaluate	5
4	A jet of water of diameter 50mm, having a velocity of 30m/sec. strikes a curved vane which is moving with a velocity of 15m/sec = in the direction of jet. The jet leaves the vane at an angle of 60^0, to the direction of motion of vanes at outlet. Determine : 1) Force exerted by the jet on the vane in the direction of motion 2) Worked done per second by the jet	Evaluate	5
5	A jet of water having a velocity of 20m/sec strikes a curved vane which is moving with a velocity of 9m/sec. The vane is symmetrical and is so shaped that the jet is deflected through 120^0. Find the angle of the jet at inlet of the vane so that there is no shock. What is the absolute velocity of the jet at	Analyze	5

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	outlet in magnitude and direction and the work done per second per unit weight of water striking? Assume the vane to be smooth.		
6	A jet of water, having a velocity of 15m/sec strikes a curved vane which is moving with a velocity of 6m/sec in the same direction as that of the jet at the inlet. The vane is so shaped that the jet is deflected through 135^0, the diameter of the jet is 150mm. assuming the vane to be smooth: 1) Find the force exerted by the jet on the vane in direction of motion. 2) Power of the vane 3) Efficiency of the vane	Apply	5
7	A jet of water having a velocity of 30m/sec strikes a series of radial curved vanes mounted on a wheel which is rotating at 300 rpm the jet makes an angle of 30^0 with the tangent to the wheel at inlet and leaves the wheel with a velocity of 4m/sec at an angle of 120^0 to the tangent to the wheel at outlet. Water is flowing from outward in the radial direction. The outer and inner radii of the wheel are o.6m and 0.3 m respectively. Determine: 1) Vane angles at inlet and outlet 2) Work done per second per kg of water. 3) Efficiency of the wheel	Apply	5
8	A jet of water having a velocity of 40 m/s strikes a curved vane ,moving with a velocity 30 m/sec strikes a curved vane, which is moving with a velocity of 18 m/s. The jet makes an angle of 30^0 with the direction of motion of vane at inlet and leaves at an angle of 90^0 to the direction of motion of vane at outlet. Draw the velocity triangles at inlet and outlet and determine the vane angles at inlet and outlet so that water enters and leaves the vane without shock.	Apply	5
9	A jet of water moving at 10 m/s impinges on vane shaped to deflect the jet through 120^0 when stationary. If the vane is moving at 5 m/s, find the angle of jet so that there is no shock at inlet. What is the absolute velocity of jet at exit in magnitude and direction and the work done per second per unit weight of water striking per second?	Apply	5
10	A jet of water having a velocity of 35 m / s impinges on a series of vanes moving with a velocity of 20 m /s the jet makes an angle of 30^0 to the direction of motion of vanes when enterning and leaves at an angle of 120^0 draw the triangles of velocities at inlet and out let with out shock. i) Find the angles of vanes tips , so that water enters and leaves with out shock ii) The work done per unit weight of water entering the vanes iii) Efficiency.	Apply	5
UNIT - IV			
Part – A (Short Answer Questions)			
1.	**Define** turbine?	Evaluate	7
2.	**Discuss** about following efficiencies : i) hydraulic efficiency ii) mechanical efficiency iii) volumetric efficiency iv) overall efficiency.	Understand	7
3.	**Discuss** about classification of hydraulic turbines.	Analyse	7
4.	**Discuss** about various parts of pelton wheel.	Evaluate	7
5.	**Discuss** about various parts of radial flow reaction turbines.	Analyse	7
6.	**Discuss** governing of turbines?	Evaluate	8
7.	**Define** surge tanks?	Remember	8
8.	**Define** the following: i) unit speed ii) unit power iii)unit discharge.	analyse	8
9.	**Discuss** about specific speed performance of turbine.	Evaluate	8
10.	**Discuss** about cavitation in turbines.	remember	8

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	Part - B (Long Answer Questions)		
1	**Define** a draft tube ? what are its functions?	Understanding	7
2	**Differentiate** between an inward and out ward flow reaction turbine ?	Evaluate	7
3	**Define** cavitation ? how can it be avoided in reaction turbine ?	Evaluate	7
4	**Understanding** by characteristic curves of a turbine ? name the important types of characteristic curves ?	Apply	7
5	**Define** the term governing of turbines ? describe with a neat sketch the working of an oil pressure governor ?	Evaluate	7
6	A pelton turbine develops 3000 Kw under a head of 300 m .The over all 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	Apply	7
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	8
8	**Derive** an expression for specific speed of a turbine .	Evaluate	8
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 5 m below the entrance to the draft tube , find the pressure head at the entrance.	Evaluate	8
10	A turbine is to operate under a head of 25 m at 200 r. p .m . The discharge is 9 cumec . If the efficiency is 90 % , determine : i) Specific speed of the turbine ii) Power generated and , iii) Type of machine.	Analyse	8
	Part – C (Problem Solving and Critical Thinking)		
1	A pelton wheel has a mean bucket speed of 100m/sec with a jet of water at the Rate of 70litres/sec uneder 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.	analyze	7
2	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 .	Apply	7
3	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.	Apply	7
4	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.	analyze	7
5	A Francis turbine with an overall efficiency of 70% is required to produce 147.15 Kw . It is working under a head of 8 m .The peripheral velocity is	analyze	7

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	3.75 m/s and radial velocity of flow at inlet is 12.02 m/s .The wheel runs at 200 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.		
6	A Kaplan turbine working under a head of 15 m develops 7357.5 Kw 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. If the velocity of whirl is zero at outlet , determine : i) runner vane angles at inlet and out let, ii) speed of the turbine	analyze	7
7	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	analyze	7
8	A turbine is to operate under a head of 30 m at 3oo 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	Apply	8
9	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 .	Apply	8
10	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 .	Apply	8
UNIT – V			
Part – A (Short Answer Questions)			
1	**Define** pump and discuss about pump installation?	Evaluate	9
2	**Discuss** about classification of pumps?	Understanding	9
3	**Define** the following :i) suction head ii) delivery head iii)static head	Remember	9
4	**Define** the following: i) manometric efficiency ii) mechanical efficiency iii) overall efficiency.	Apply	9
5	**Explain** minimum speed for starting a centrifugal pump?	Remember	9
6	**Define** multi stage centrifugal pump?	Create	9
7	**Discuss** about performance of pumps?	Apply	9
8	**Draw** the characteristic curves of pumps	Evaluate	9
9	**Discuss** about the classification of hydro power plants.	Remember	10
10	**Define** the following : i) load factor ii)utilization factor iii)capacity factor	Remember	10
Part - B (Long Answer Questions)			
1	**Define** a centrifugal pump. Explain the working of a single –stage centrifugal pump with sketches.	Apply	9
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.	Evaluate	9
3	**Define** the terms i) suction head ii)delivery head iii)static head iv) manometric head	Evaluate	9

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4	**Explain** manometric efficiency , mechanical efficiency and over all efficiency of a centrifugal pump ?	Evaluate	9
5	**Obtain** an expression for the work done by the impeller of a centrifugal pump on water per second per unit weight off water.	Apply	9
6	**Derive** an expression for the minimum speed for starting a centrifugal pump?	Analyse	9
7	**Differentiate** between single stage and multi stage pump? Describe multi stage pump with a) impellers in parallel b)impellers in series.	Apply	9
8	**Define** the specific speed of a centrifugal pump. Derive an expression for the same.	Apply	9
9	**Explain** the specific speed of a centrifugal pump differs from that of a turbine ?	Analyse	9
10	**Define** priming? Why is it necessary?	Apply	9
	Part – C (Problem Solving and Critical Thinking)		
1	The internal and external diameters of the impeller 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 20^0 and 30^0 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.	Apply	9
2	Find the rise in pressure in the impeller of a centrifugal pump through which water is flowing at the rate of 15 litre/s . The internal and external diameters of the impeller are 20 cm and 40 cm respectively . The widths of impeller at inlet and out let are 1.6 cm and 0.8 cm. The pump is running at 1200 r .p . m. The water enters the impeller radially at inlet and impeller vane angle at out let is 30^0. Neglect losses through the impeller.	Apply	9
3	The diameters of an impeller of a centrifugal pump at inlet and outlet are 20 cm 40 cm respectively. Determine the minimum speed for starting the pump if it works against a head of 25 cm .	Apply	9
4	The diameter of an impeller of a centrifugal pump at inlet and out let are 300 mm and 600 mm respectively .the velocity of flow at out let 2.5 m/s and vanes are set back at an angle of 45^0 at out let determine the minimum starting speed of the pump if the manometric efficiency 75%.	Apply	9
5	A three stage centrifugal pump has impeller 40 cm in diameter and 2.5 cm wide at outlet .The vanes are set back at the outlet at 30^0 and reduce the circumferential area by15 % . The manometric efficiency is 85 % and over all 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.	Apply	9
6	Find the number of pumps required to take water from a deep well under total head of 156 m. also the pumps are identical and are running at 1000 rpm . The specific speed of each pump is given as 20 while the rated capacity of each pump is 150 litres/sec .	Analyze	9
7	The diameter of a centrifugal pump , which is discharging 0.035 m^3/s of water against a total head of 25 m is 0.05m the pump is running at 1200 rpm . find the head , discharge and ratio of powerof a geometrically similar pump of diameter 0.3 mwhen it is running at 2000 rpm	Apply	9
8	A centrifugal pump rotating at 1000 rpm delivers 160 litres/sec of water against a head of 30 m the pump is installed at a place where atmospheric pressure is 1 $X10^5$ pa (abs) and vapour pressure of water is 3 k pa (abs) the head loss in suction pipe is equivalent to 0.2 m of water calculate i) minimum NPSH . ii) maximum allowable height of pump from free surface of water in	Evaluate	9

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	the sump .		
9	A centrifugal pump discharges 0.15 m^3/sec of water against a head 12.5 m , the speed of the impeller being 600 rpm .The outer and inner diameters of the impeller are 500 mm and 250 mm respectively and the vanes are bent back at 35^0 to the tangent at exit .If the area of flow remains 0.07 m^2 from inlet to out let , calculate : i) manometric efficiency of pump, ii) vane angle at inlet and iii) loss of head at inlet to impeller when the discharge is reduced by 40 % with out changing the speed .	analyze	9
10	A three stage centrifugal pump has impellers 40 cm diameter and 2 cm wide at outlet .The vanes are curved back at the out let at 45^0 and reduce the circumferential area by 10 % .the manometric efficiency is 90 %.and the over all efficiency is 80 % .determine the head generated by the pump when running at 1000 rpm delivering 50 liters/sec what should be the shaft horse power ?	Apply	9

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