Hall Ticket No | | | | | | | | | | Question Paper Code: ACE016

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER - II

B. Tech V Semester End Examinations, November - 2019

Regulations: R16

HYDRAULIC AND HYDRAULIC MACHINERY

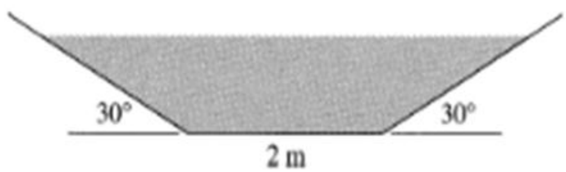
(CIVIL ENGINEERING)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

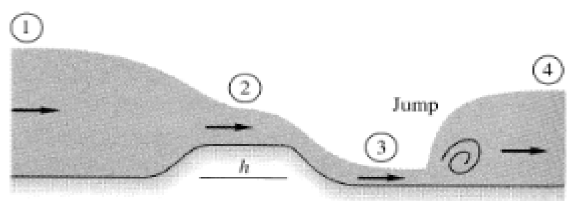
1. a) The Trapezoidal channel is made of brickwork with side slopes as 1:500 as shown in the following figure. Determine the flow rate and most economical depth if the normal depth is 80 cm. **[7M]**



b) At the bottom of an 80' wide spillway is a horizontal hydraulic jump with water depths 1' upstream and 10' downstream. Estimate (a) the flow rate; and (b) the horsepower dissipated. **[7M]**

(OR)

2. a) Water in a horizontal channel accelerates smoothly over a bump and then undergoes a hydraulic jump, as shown in figure. If y_1 = 1 m and y_3 = 40 cm, estimate V1, V3, Y4 and bump height. **[7M]**



b) A circular painted-steel channel, of radius 50 cm, is running half-full at 1.2 m^3 /s on a slope of 5 m/km. Determine **[7M]**
(i) Whether the slope is mild or steep; and
(ii) What type of gradually- varied solution applies at this point.
(iii) Use the approximate Method and a single depth increment Δy = 5 cm, to calculate the estimated Δx for this new "y".

UNIT – II

3. a) A formula for estimating the mean free path of a perfect gas is shown below. where latter form follows from the ideal-gas law, ρ = p/RT. What are the dimensions of the constant "1.26"? Estimate the mean free path of air at 20°C and 7 kPa. Is air rarefied at this condition? **[7M]**

$$\ell = 1.26 \frac{\mu}{\rho\sqrt{(RT)}} = 1.26 \frac{\mu}{p}\sqrt{(RT)}$$

b) Test the dimensional homogeneity of the boundary-layer x-momentum equation: **[7M]**

$$\rho u \frac{\partial u}{\partial x} + \rho v \frac{\partial u}{\partial y} = -\frac{\partial p}{\partial x} + \rho g_x + \frac{\partial \tau}{\partial y}$$

(OR)

4. a) An oil of specific gravity 0.92 and viscosity 0.03 poise is to be transported at the rate of 2500 liters / sec, through a 1.2 m diameter pipe. Tests were conducted on a 12 cm diameter pipe using water at 20^0 C. If the viscosity of water at 20^0 C is 0.01 poise find: Velocity of flow in the model and Rate of flow in the model. **[7M]**

b) Using the concept of Dimensional analysis, prove that velocity through an orifice can be expressed as shown below. Assume H = head causing flow, D = Diameter of Orifice, μ = Co – efficient of viscosity, ρ = Mass density and σ = Surface tension **[7M]**

$$V = \sqrt{2gh}\ \emptyset \left[\frac{D}{H},\quad \frac{\mu}{\rho V H},\quad \frac{\sigma}{\rho v^2 H}\right]$$

UNIT – III

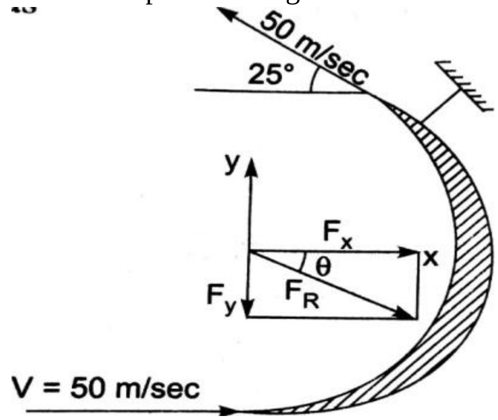
5. a) A two-dimensional sheet of water, 10 cm thick and moving at 7 m/s, strikes a fixed wall inclined at 20° with respect to the jet direction. Assuming frictionless flow, find **[7M]**
(a) the normal force on the wall per meter of depth, and the widths of the sheet deflected
(b) upstream, and
(c) down stream along the wall.

b) A jet of water of diameter 60 mm moving with a velocity of 40 m/s, strikes a curved fixed symmetrical plate at its center. With a neat sketch, find the force exerted by the jet of water in the direction of the jet, if the jet is deflected through an angle of 120^0 at the outlet of the curved plate. **[7M]**

(OR)

6. a) A jet of water moving with a velocity of 20 m/s impinges on a curved vane, which is moving with a velocity of 10 m/s. The jet makes an angle of 20^0 leaves with the direction of motion of vane at inlet and leaves at angle of 130^0 to the directions of motion of vane at outlet. Determine: **[7M]**
i. The angle of curved vane tips so that water enters and leaves without shock.
ii. The work done per N if water entering the vane.

b) A stationary vane having an inlet angle of zero degree and an outlet angle of 250 as shown in figure, receives water at a velocity of 50 m/s. Determine the components of fore acting on it in the direction of the jet velocity and normal to it. Also find the resultant force in magnitude and direction per unit weight of the flow. **[7M]**



UNIT – IV

7. a) In a jet propelled boat water is drawn amidships and discharged at the back with an absolute velocity of 20 m/s. If the cross - sectional area of the jet is 200 cm^2 and the boat is moving in sea water with a speed of 8.33 m/s Determine: **[7M]**
   i. The propelling force on the boat
   ii. Power required to drive the pump and
   iii. Efficiency of jet propulsion.

   b) A Kaplan turbine runner is to be designed to develop 9100 KW. The net available head is 5.6 m. If the speed ratio = 2.09., flow ratio = 0.68, overall efficiency = 86% and the diameter of the boss is 1/3 the diameter of the runner. Find the diameter of the runner, its speed and the specific speed of the turbine. **[7M]**

(OR)

8. a) 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 at the entrance. **[7M]**

   b) A Pelton wheel develops 8000 KW under a net head of 130 m at a speed of 200 r. p. m. assuming the co-efficient of velocity for the nozzle 0.98, hydraulic efficiency 87 % , speed ratio 0.46, and jet diameter to wheel diameter $\frac{1}{9}$. Assume Mechanical Efficiency = 75 %. Determine **[7M]**
   i. The discharge required
   ii. The diameter of the wheel
   iii. The diameter and number of jets required and
   iv. The specific speed.

UNIT – V

9. a) A centrifugal pump is to discharge 0.118 m^3 / s at a speed of 1450 r. p. m against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and monomeric efficiency is 75 %. Determine the vane angle at the outer periphery of the impeller. **[7M]**

b) A centrifugal impeller has dimensions and blade angles as given below. Water at the rate of 60 liters per second enters the impeller radially and the radial velocity remains constant in the impeller. Determine the impeller speed and torque produced by it. Use the following data: $R_1 = 7.5$ cm, $R_2 = 15$ cm, $\beta_1 = \beta_2 = 30^0$. Impeller inlet area – $A_1 = 250$ cm^2. **[7M]**

(OR)

10. a) Find the rise in pressure in the impeller of a centrifugal pump through which water is flowing at the rate is 1.5 liter / s. The internal and external diameters of the impeller are 20 cm and 40 cm respectively. The widths of the impeller at inlet and outlet 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 vane angle at outlet is 30^0. Neglect losses through the impeller. **[7M]**

b) Two geometrically similar pumps are running at the same speed of 1000 r. p.m. One has an impeller of 0.4 m and discharge of 30 l/s against a head of 20 m. If the other pump gives half of this discharge rate, determine the head and diameter of the second pump. **[7M]**

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COURSE OBJECTIVES:

The course should enable the students to:

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

COURSE OUTCOMES (COs):

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

COURSE LEARNING OUTCOMES (CLOs):

ACE011.01	Explain the concept for types of flows, type of channels, Non uniform flow - Dynamic equation for G.V.F., Mild, Critical, and Steep channels
ACE011.02	Understand concept of velocity distribution, energy and momentum correction factors for different flows.
ACE011.03	Understand Chezy's, Manning's and Basin formulae for uniform flow.
ACE011.04	Explain the concepts based on Specific energy, critical depth, critical, subcritical and super critical flows.
ACE011.05	Understand and designing for the computation of economical sections based on flow parameters and channel characteristics.
ACE011.06	Understand the Dimensional quantities and analysis for various parameters.
ACE011.07	Derive the problems based on Rayleigh's method and Buckingham's pi theorem with applications.
ACE011.08	Explain the concept of similitude with examples and different types of similitude concepts.
ACE011.09	Remember the concepts of dimensionless numbers to solve numerical problems.
ACE011.10	Explain the practical problems associated with model and prototypes based on concept of similitude.

ACE011.11	Explain the different types of jets used in construction of turbines and machinery and their importance.
ACE011.12	Demonstrate the formulation of velocity triangles at inlet and out let of vanes with different combinations of jet.
ACE011.13	Derive the expressions based on Angular momentum principle, work done and efficiency for various types of vanes.
ACE011.14	Explaining the concepts of hydro power plant with various components and their functioning.
ACE011.15	Deriving numerical problems based on power developed in Hydro power plant, efficiency of jet, stationary and moving vanes.
ACE011.16	Demonstrating different types of turbines with their principles and practical applications
ACE011.17	Remember the concept of work done, efficiency for different vanes and application to the concept of turbines.
ACE011.18	Deriving the expressions for most economical design of turbines to withstand for the designed discharge.
ACE011.19	Understand the working principles for various and working of different components of Kaplan, Francis and Pelton turbines.
ACE011.20	Understand the working mechanism of different types of pumps, importance and functioning of various components.
ACE011.21	Explain characteristic curves for pumps with their practical applications
ACE011.22	Understand the concept of NPSH, performance of pumps and working efficiency.
ACE011.23	Explain the designing of reciprocating pump and centrifugal pump.
ACE011.24	Understand the practical problems associated during the installation of pumps
ACE011.25	Understand the concept ANOVA to the real world Problems to measure the atmospheric tides.

MAPPING OF SEMESTER END EXAMINATION - COURSE OUTCOMES

SEE Question No		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	ACE011.05	Understand and designing for the computation of economical sections based on flow parameters and channel characteristics	CO 1	Understand
	b	ACE011.03	Understand Chezy's, Manning's and Basin formulae for uniform flow	CO 1	Understand
2	a	ACE011.05	Understand and designing for the computation of economical sections based on flow parameters and channel characteristics	CO 1	Understand
	b	ACE011.01	Explain the concept for types of flows, type of channels, Non uniform flow - Dynamic equation for G.V.F., Mild, Critical, and Steep channels	CO 1	Understand
3	a	ACE011.10	Explain the practical problems associated with model and prototypes based on concept of similitude	CO 2	Understand
	b	ACE011.09	Remember the concepts of dimensionless numbers to solve numerical problems	CO 2	Remember
4	a	ACE011.10	Explain the practical problems associated with model and prototypes based on concept of similitude	CO 2	Understand
	b	ACE011.09	Remember the concepts of dimensionless numbers to solve numerical problems	CO 2	Understand

5	a	ACE011.12	Demonstrate the formulation of velocity triangles at inlet and out let of vanes with different combinations of jet.	CO 3	Understand
	b	ACE011.13	Derive the expressions based on Angular momentum principle, work done and efficiency for various types of vanes.	CO 3	Understand
6	a	ACE011.12	Demonstrate the formulation of velocity triangles at inlet and out let of vanes with different combinations of jet.	CO 3	Understand
	b	ACE011.15	Deriving numerical problems based on power developed in Hydro power plant, efficiency of jet, stationary and moving vanes.	CO 3	Understand
7	a	ACE011.17	Remember the concept of work done, efficiency for different vanes and application to the concept of turbines.	CO 4	Understand
	b	ACE011.19	Understand the working principles for various and working of different components of Kaplan, Francis and Pelton turbines.	CO 4	Understand
8	a	ACE011.18	Deriving the expressions for most economical design of turbines to withstand for the designed discharge.	CO 4	Understand
	b	ACE011.19	Understand the working principles for various and working of different components of Kaplan, Francis and Pelton turbines	CO 4	Understand
9	a	ACE011.24	Understand the practical problems associated during the installation of pumps and turbines	CO 5	Understand
	b	ACE011.24	Understand the practical problems associated during the installation of pumps and turbines	CO 5	Understand
10	a	ACE011.22	Understand the concept of NPSH, performance of pumps and working efficiency	CO 5	Understand
	b	ACE011.22	Understand the concept of NPSH, performance of pumps and working efficiency	CO 5	Understand

Signature of Course Coordinator **HOD, CE**