Code No: R09220103 **R09** **Set No. 2**

II B.Tech II Semester Examinations,April/May 2012
HYDRAULICS AND HYDRAULIC MACHINES
Civil Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks
⋆⋆⋆⋆⋆

1. (a) Give the classification of hydropower schemes according to the extent of heads and bring out the salient features with the help of neat sketches.
   (b) Explain the following terms in connection with the hydro power plants:
      i. Gross head
      ii. Net head
      iii. Productive head. [7+8]

2. (a) Derive an expression for the hydraulic efficiency when a liquid jet strikes a single moving curved vane.
   (b) 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 the vanes when entering and leaves at an angle of 120^0. Draw the velocity triangle and find:
      i. The angles of vane tips so that water enters and leaves without shock
      ii. The work done per unit weight of water entering the vanes
      iii. The efficiency. [7+8]

3. (a) Describe with a sketch, the installation and operation of a centrifugal pump.
   (b) List out the difficulties that are generally encountered in operating centrifugal pumps. [7+8]

4. (a) What are the functions governing the hydraulic turbine? Explain with a sketch, the governing mechanism of an impulse turbine.
   (b) A 65 cm diameter turbine runner develops 60 KW under a head of 30 m. Its speed is 4200 rpm. Compute its specific speed and unit speed. It is required to build a similar turbine to develop 250 KW under a head of 40 m. Calculate the required diameter. [7+8]

5. Determine the discharge in the channels having the following sections for d=2m, N=0.013 and and $S=3\times10^{-3}$.
   (a) Rectangular Section, 2 m wide
   (b) Circular Section, 4.5 m diameter
   (c) Triangular Section with bottom angle of 45^0, and
   (d) Trapezodial Section 6m wide having side slopes of 1:1. [15]

6. (a) Show by dimensional analysis, that the power P developed by a hydraulic turbine is given by: $P = \rho N^3 D^5 f\left[\frac{N^2D^2}{gH}\right]$ where ρ is the mass density of liquid, N is the rotational speed, D is the diameter of runner, H is the working head and g is the gravitational acceleration.

   (b) A 1: 50 spillway model has a discharge of 1:25 m^3/s. What is the corresponding prototype discharge? If a flood phenomenon takes 12 h to occur in the prototype, how long should it take in the model? [7+8]

7. (a) What are the main differences in Runners of Francis and Kaplan turbines? Explain.

   (b) Find the mean diameter and blade angles at inlet and outlet of an inward flow reaction turbine. of the following perticulars:
   Output = 20,00hp Speed = 300rpm
   Head = 120m $\frac{Inner\ diameter}{Outer\ diameter} = 0.6$
   Axial length of balde at inlet = 0.1 × Corresponding diameter
   Flow ratio = 0.15
   Hydraulic efficiency = 88%
   Overall efficiency = 85%
   Assume radial discharge, Velocity of flow constant throughout and area blocked by blade thickness as 5% of area of flow. [7+8]

8. (a) Identify the GVF profiles in the following cases:
   i. above CDL on a horizontal bed
   ii. between CDL and channel bed on a mild slope
   iii. between NDL and CDL on a steep slope
   iv. below CDL on a critical slope.

   (b) The depth and velocity of water downstream of a sluice gate in a horizontal rectangular channel are 0.4 m and 6 m/s respectively. Examine, whether a hydraulic jump can possibly occur in the channel. If so, find its sequent depths, head loss, relative loss and efficiency. [7+8]

⋆⋆⋆⋆⋆

Code No: R09220103 **R09** **Set No. 4**

II B.Tech II Semester Examinations,April/May 2012
HYDRAULICS AND HYDRAULIC MACHINES
Civil Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

⋆⋆⋆⋆⋆

1. (a) How a specific speed differs from a unit speed in a turbine? Explain.
   (b) A turbine is to operate under a head of 25m at 200rpm. The available discharge is $9m^3$/Sec. Assuming an efficiency of 90%, determine:
      i. the specific speed
      ii. power generated
      iii. performance under a head of 20m
      iv. the type of turbine. [7+8]
2. (a) Give Manning's formula, explaining all the terms involved.
   (b) Derive a relation between Chezy's C and Manning's N.
   (c) A canal of rectangular cross section is to carry 12 m^3/sec of water with a velocity of 2.5 m/sec. Design the most economical section for the canal. Take Chezy's constant as 50. Also calculate the necessary slope for the bed of the channel. [5+5+5]
3. (a) Distinguish clearly between Rapidly Varied Flow and Gradually Varied Flow in terms of critical flow and Froude numbers.
   (b) A discharge of 1000 litres/sec flows along a rectangular channel 1.5m wide. What would be the critical depth in the channel? If a standing wave were to be formed at a point, when the upstream depth is 18cm, what would be the rise in water level? [7+8]
4. (a) Show that the efficiency of a Pelton wheel is maximum when the velocity of the buckets equals half the velocity of the jet.
   (b) An inward flow reaction turbine operates under a head of 30m running at 200rpm. The runner diameter is 1m and the radial velocity at runner exit is 6m/sec. Assuming the hydraulic losses as 25% of the available head, determine
      i. Guide vane exit angle
      ii. runner vane angles
      iii. power produced by the turbine. [7+8]
5. (a) Explain the role of cavitation in centrifugal pumps.
   (b) Two geometrically similar pumps are running at the same speed of 1440 rpm. One pump has an impeller diameter of 40 cm and lifts 1000 liters per minute of water against a head of 20 m. Determine the head and the impeller diameter of the second pump to deliver 50% discharge. [7+8]

6. (a) What are the different classes of load a power system is expected to serve? Draw a typical load curve and explain the Base load and peak load.
   (b) A central power station has annual factors as follows:
   Load factor = 60%
   Capacity factor = 40%
   Plant use factor = 45%
   Power station has a maximum demand of 15000kW. Determine:
      i. Annual energy production
      ii. Reserve capacity over and above peak load
      iii. Hours per year not in service. [7+8]

7. (a) A jet of water of 5 cm diameter and velocity 40 m/s enters a stationary curved vane at 20^0 to horizontal and leaves at 30^0 to horizontal so that the total deflection angle of the jet is 130^0. Assuming the flow to be frictionless and shockless, compute the magnitude and direction of the force on the vane.
   (b) A wheel having radial blades has 1 m dia at the outer tip and 70 cm at the inner tip. Water is entering at the outer tip with a velocity of 30m/sec at an angle of 30^0 with tangent and leaves the blade with a velocity of flow 5 m/sec. Blade angle at entrance is 35^0 and at exit 40^0. Calculate:
      i. Speed of the wheel
      ii. The work done/kg of water entering the wheel
      iii. Efficiency. [7+8]

8. (a) Check whether the following equations are dimensionally homegeneous.
      i. Q = C_d a $\sqrt{2gH}$
      ii. Q = 1.84 [b-0.1nH]$H^{3/2}$
      iii. V = C$\sqrt{RS}$

   Where Q is the discharge
   a is the area of Orifice
   H is the Head Causing flow
   b is the length of the weir
   V is the Velocity of flow
   R is the Hydraulic Radius
   S is the slope of Water Surface, C & Cd are the coefficients.
   (b) The equation given below is valid for FPS system. Find the corresponding equation in MKS system.
   S = $0.513\frac{\mu V}{D^2}$
   Where S is the slope of the energy line
   μ is the Viscosity
   V is the Velocity, and
   D is the depth. [7+8]

⋆⋆⋆⋆⋆

Code No: R09220103 **R09** **Set No. 1**

II B.Tech II Semester Examinations,April/May 2012
HYDRAULICS AND HYDRAULIC MACHINES
Civil Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

⋆⋆⋆⋆⋆

1. (a) What is a Governor? What is its purpose? Draw a sketch of a typical Governor and show its components.
   (b) A turbine works under a head of 16m at a speed of 200 rpm and develops 500 hp when the rate of flow of water is $2.5m^3$/Sec. If the head on the turbine is increased to 25m, calculate the new speed, discharge and power. [7+8]

2. (a) Explain the location and function of the following in a hydroelectric power plant.
      i. Intake structure
      ii. Pen stock
      iii. Anchor block.
   (b) Discuss with neat sketches the classification of Hydroelectric plants based on storage characteristics. [7+8]

3. (a) What are the advantages of a reaction turbine over the Pelton wheel in respect of size, efficiency, cost and maintenace?
   (b) A Pelton wheel has a tangential velocity of 18m/Sec when discharge and head are $0.25m^3$/Sec and 40m respectively. If the bucket deflects the jet through 160^0, determine the power produced by the turbine. Take $C_V = 0.98$. [7+8]

4. (a) Show that $\frac{Q^2}{g}=\frac{A^3}{T}$, where Q is the discharge, A is the Area of flow, T is the Topwidth of Water Surface of an open channel and g is the acceleration due to gravity; for a critical flow to occur in an open channel.
   (b) The specific energy in a rectangular channel is 3 kgm/kg. Calculate the critical depth. Also compute the maximum discharge that can occur if the width of the channel is 6m. [7+8]

5. (a) Derive an expression for the work done per second on a series of moving curved vanes by a jet of water striking at one of the tips of the vane and draw velocity diagrams.
   (b) A jet water having a velocity of 15 m/s strikes a curved vane which is moving with a velocity of 5 m/s. The vane is symmetrical and it 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 outlet in magnitude and direction and the work done per unit weight of water. Assume the vane to be smooth. [7+8]

6. (a) Derive the expression for depth after jump d_2:
$d_2 = \frac{d_1}{2}\left[\sqrt{1+8Fr_1^2}-1\right]$
Where d_1 is the depth before jump and Fr_1 is the Froudis number before the jump.

(b) A rectangular channel which is 7m wide carries a discharge of 12 cumees. If the mean velocity of flow before the hydraulic jump is 7m/sec, calculate the height of the jump and the energy dissipated. [7+8]

7. (a) A sphere of diameter and density ρ settles at a terminal velocity v in a liquid of density ρ_1 and dynamic viscosity μ . Represent the velocity in terms of other parameters in terms of non-dimensional form using Buckingham pi-theorem g is also a parameter.

(b) An under water device of 1.5m long is to move at a speed of 3.5 m/s. A geometrically similar model of 30 cm long is tested in a variable pressure wind tunnel at a speed of 35m/s. Calculate the pressure of air in the model. If the model exhibits a drag force of 40 N. Calculate the prototype drag force.
Take $\rho_{water} = P_p = 998$kg/m^3. ρ_a(atmospheric air density) = 1.17 kg/m^3.
$\mu_{air} = \mu_m = 1.9 \times 10^{-5} =$ Pa.s and $\mu_{water} = \mu_p = 1 \times 10^{-3}$ Pa.s. [7+8]

8. (a) Explain clearly the meaning of Manometric head. How is it different from static head? Explain.

(b) A centrifugal pump is running at 1000rpm. The outlet vane angle of the impeller is 45^0 and velocity of flow at outlet is 2.5m/Sec. The discharge through the pump against a total head of 20m. If the mano metric efficiency of the pump is 80%, determine:

i. diameter of the impeller
ii. width of the impeller at outlet. [7+8]

⋆⋆⋆⋆⋆

Code No: R09220103 **R09** **Set No. 3**

II B.Tech II Semester Examinations,April/May 2012
HYDRAULICS AND HYDRAULIC MACHINES
Civil Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A wheel having radial blades has the inner and outer radii of 30cm and 50cm respectively. The jet enters the blades at the outer tip with a velocity of 30m/Sec at an angle of 30^0 to the tangent and leaves the blades with a velocity of flow of 5m/Sec. If the angles of the blades at entrance and exit are respectively 45^0 and 35^0, find the workdone per kg of water entering the wheel, the speed of the wheel and its efficency. [15]

2. Prove that the resistance F of a sphere of diameter d moving at a constant speed v through a fluid of density and dynamic viscosity μ may be expressed as $F = \frac{\mu^2}{\rho}\phi\left[\frac{vd\rho}{\mu}\right]$ [15]

3. (a) What is a back water curve. Explain with practical examples. Differentiate between back water curve and draw down curve.
   (b) How will you prove the rate of change of depth along channel depends on bed slope, ratio of the normal depth to the actual depth 'd' and the ratio of the critical depth dc to the actual depth 'd'. [7+8]

4. (a) What is a contrifugal pump? What is the basic principle on which it works? Explain.
   (b) A contrifugal pump with radial inflow delivers 0.08 cumecs of water against a total head of 40m. If the outer diameter of the impeller is 30cm and its width at the outer periohery is 1.25cm, find the blade angle at exit. The speed of the pump is 1500rpm and its manometric efficiency is 80%. [7+8]

5. (a) Show how the performance of a turbine may be predicted by a geometrically similar model.
   (b) A hydraulic turbine develops 10MW under a head of 12m at a speed of 90rpm and gives an efficiency of 93%. Calculate the specific speed and discharge. If a model 1/10 of the prototype is tested under a head of 10m, what must be its speed, power and discharge to run under similar conditions? [7+8]

6. (a) Give neat sketches and the salient features of the following types of draft tubes:
      i. straight conical draft tube
      ii. Moodys hydra cone
      iii. elbow type tube.

(b) An inward flow reaction turbine has inner and outer diameter of the wheel as 350mm and 750mm respectively. The vanes radial at inlet and the discharge is radial at outlet. The water enters the vane at an angle of 120. Assuming the velocity of flow to be constant and equal to 3.5m/sec, find the speed of the wheel and the vane angle at outlet. [7+8]

7. (a) Velocity distribution in an open channel is given by $u = \left(1.0 + \frac{y}{y_0}\right)$ where y_0 is normal depth. Determine energy and momentum correction factor's α and β.

(b) A trapezoidal channel with bottom width of 4.0m and side slopes 1:1 has Manning's N of 0.02. If it carries a discharge of 2.485 m^3/sec at a depth of 1.0m, calculate average velocity and bed slope. [7+8]

8. (a) Describe with sketches, different component parts of a high head hydropower development and explain their functions. Is surge tank a must in high head development. Discuss.

(b) A run - off - river hydroelectric power station is proposed across a river at a site where a net head of 22 m is available on the turbine. The river carries a sustained minimum flow of 24 cumecs in dry weather and behind the power station, sufficient pondage is provided to supply daily peak load of demand with a load factor of 72%. Assuming plant efficiency of 60%, determine maximum generating capacity of the generator to be installed at the power house. If the daily load pattern indicates 20 hours average load and 4 hours of peak load, determine the volume of pondage to be provided to supply the daily demand. [7+8]

⋆⋆⋆⋆⋆