

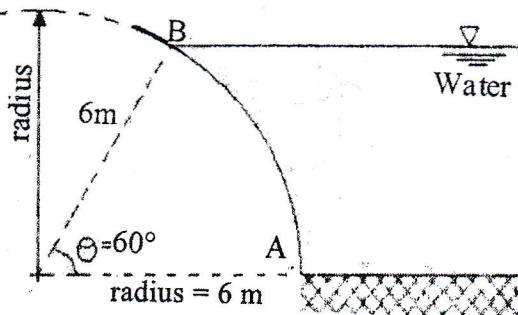
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject:** - Hydropower (CE660)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



1. Define the terms specific weight, specific gravity, specific mass, specific volume, viscosity, surface tension, Capillarity and compressibility. [4]
2. The sector gate shown in figure below consists of a cylindrical surface of which AB is the trace, supported by a structural frame hinged at O. The length of the gate is 10m. Determine the magnitude and location of the horizontal and vertical component of the total hydrostatic force on the gate. [10]



3. What is the condition required for the most efficient trapezoidal section? Determine the normal depth for a triangular channel with side slope 2H: 1V and longitudinal slope 0.0005 to carry discharge of  $0.5 \text{ m}^3/\text{s}$  if manning's coefficient n is 0.04. [2+6]
4. Discuss hydrological cycle and describe about the different methods of finding the mean precipitation over an area. [4+6]
5. Following are the mean monthly flow of the river [7]

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Flow( $\text{m}^3/\text{s}$ )	100	120	140	300	320	1800	2000	2510	2000	900	100	300

- Where head ( $H$ ) = 100m, overall efficiency = 90% and design discharge selected is  $900 \text{ m}^3/\text{s}$ . Calculate the annual firm and secondary energy.
6. What do you mean by dam? Enlist types of dam based on various criteria. Write the possible forces acting on gravity dam with a neat sketch. [1+4+4]
  7. A penstock is to convey  $6 \text{ m}^3/\text{s}$  discharge with a design head of 60m. Determine the economic diameter of the penstock based on i) USBR formula, ii) Sarkaria formula, and iii) formula based on graphical solution. Take  $n = 85\%$ . [8]
  8. a) What is the function of surge tank in hydropower plant? [2]
  - b) What is spillway? Classify it as per the pertinent features. Discuss ogee spillway with a neat sketch. [1+1+4]
  9. Write down the function of a draft tube. Describe the selection criteria of hydraulic turbines for hydroelectric power plants. [2+6]
  10. Design a pelton wheel turbine for a hydro-electric plant having a net head of 310m, design discharge of  $5 \text{ m}^3/\text{s}$  and 86% efficiency of the turbine. [8]

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1. Calculate the dynamic viscosity of oil which is used for the lubrication between square plate of size  $0.8m \times 0.8m$  and an inclined plane with an angle of inclination  $30^\circ$ . The weight of the square plate is  $300N$  and it slides down the inclined plane with a uniform velocity of  $0.3m/s$ . The thickness of oil film is  $1.5mm$ . [7]
2. Derive the geometrical conditions for the most economical section of a rectangular channel. [6]
3. A rectangular plate  $3m \times 5m$  is immersed vertically in water such that the  $3m$  side is parallel to the water surface. Determine the hydrostatic force and the centre of pressure if the top edge of the surface is (i) flush with the water surface, and (ii)  $2m$  below the water surface. [6]
4. How do you numerically classify laminar, transitional and turbulent flow in pipes? Differentiate laminar and turbulent velocity profiles in pipe flow with neat sketch and labels. [2+6]
5. Compute the river discharge by mid-section with the help of following data: [8]

Distance from the left bank (m)	Depth (m)	Velocity (m/s)			Where $y$ is the depth of flow
		0.6y	0.2y	0.8y	
0	0	-	-	-	
1.2	0.7	0.4	-	-	
2.4	1.7	-	0.7	0.5	
3.6	2.5	-	0.9	0.6	
4.8	1.3	-	0.6	0.4	
6.0	0.5	0.35	-	-	
7.2	0	-	-	-	

6. Discuss working principle of centrifugal and reciprocating pumps. [5]
7. Explain Power market, Hydrology and Geology as a planning parameter for hydropower development. [6]

8. Explain elementary profile of dam and prove that  $B = \frac{H}{\sqrt{G - K}}$  where B is base width, H is height of water at the upstream side of the dam, G is specific gravity of dam material and K is uplift pressure intensity coefficient. [7] [6]
9. Explain about surge tank, its functions and design criteria with necessary sketch.
10. Define firm power and secondary power. The load on a hydropower plant varies from a minimum of 12,000 kW to a maximum of 35,000 kW. Two turbo-generators of capacities 22,000 kW each have been installed. Calculate:  
(i) total installed capacity of the plant,  
(ii) plant factor,  
(iii) maximum demand,  
(iv) load factor, and  
(v) utilization factor. [1+7]
11. What is economic diameter of penstock? How do you determine the economic diameter of a penstock. [8]
12. What factors do you keep in mind while selecting an intake site in a RoR hydropower plant? [5]

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1. State the Newton's law of viscosity and explain the importance of viscosity in fluid motion. [1+4]
2. Define the terms total pressure and centre of pressure. Derive expressions for total pressure and centre of pressure for a vertically immersed surface. [2+3+3]
3. Explain the total energy line and the hydraulic gradient line for fluid flow through a piping system with neat sketch. [4]
4. Find the rate of flow 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 C = 55. [8]
5. Compute the discharge of a stream with the following data. [10]

Distance from left bank (m)	0	2	4	6	8	10	12
Depth (m)	-	0.9	2.4	2.2	1.0	0.6	-
Velocity at 0.2d	-	0.6	0.9	0.7	0.6	0.4	-
Velocity at 0.8d	-	0.4	0.6	0.5	0.4	0.3	-

6. Determine the primary and secondary energy if the hydrograph as shown below is given net head = 200 m and efficiency = 80%. What is the volume of the pondage required if the firm capacity is increased by 150%. [10]

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Discharge (m <sup>3</sup> /s)	100	120	140	300	320	1800	2000	2510	2000	900	500	300

7. a) What is meant by elementary profile of a gravity dam? Explain for fixing the width of the elementary profile of concrete gravity dam by considering no tension and no sliding criteria. [3+5]
- b) Why settling basin is essential in hydropower electric project in Nepal? Draw a layout plan and section of typical settling basin along with its design criteria. [3+3]
8. What is meant by economic diameter of tunnel? How do you work out it? [1+5]
9. a) What are the functions of forebay? Describe briefly about the layout of forebay on hydropower project with neat sketch. [2+3]
- b) Describe the criterions to be considered while designing a settling basin. [5]
10. What are the objectives of the provision of surge tank for the hydropower project? Discuss the various factors which govern the determination of economical diameter of penstock. [1+4]

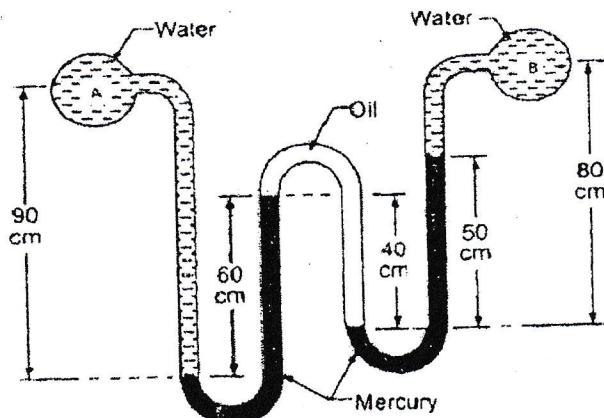
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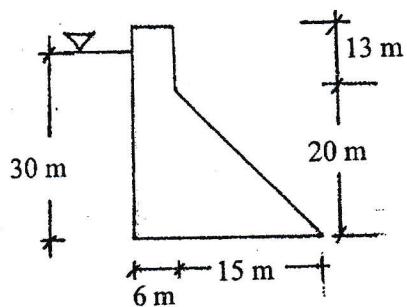


1. Calculate the pressure difference between the points A and B. Specific gravity of oil is 0.8. [5]



2. Define total pressure and center of pressure in static fluid prove that the center of pressure for a vertically immersed plane surface is always below its centroid. [2+6]
3. Derive Bernoulli's equation with the help of Euler's equation of fluid motion for a real flow. Sketch HGL and EGL for the horizontal circular pipe of gradually expanding cross-section towards the direction of flow. [2+2]
4. Verify that for the most economical trapezoidal channel, the length of one channel side must be equal to half the length of the top-width of the section. [6]
5. The following are the data obtained in a stream-gauging operation. A current meter with a calibration equation  $V = (0.55N + 0.04) \text{ m/s}$ , where  $N = \text{revolutions per second}$  was used to measure the velocity at 0.6 depth. Calculate the discharge in the stream. [7]
6. What is water hammer? Write down the problems with water hammer. Water is flowing through a cast-iron pipe of diameter 150 mm and thickness 10 mm which is provided with a valve at its end. Water is suddenly stopped with closing the valve. Find the maximum velocity of water, when rise of pressure due to sudden closure of valve is  $1.962 \text{ MN/m}^2$ . Take  $K = 1.962 \text{ GN/m}^2$  and  $E = 117.7 \text{ GN/m}^2$ . [1+2+5]
7. What do you mean by economical diameter of penstock pipe? How it can be achieved? [1+4]
8. Explain hydraulic tunnels and its design features. [1+5]
9. What is cavitation? What are its effects and how can it be avoided in reaction turbines? [1+2+2]

10. Explain the differences between Pre-feasibility and Feasibility studies in hydropower projects. [4]
11. Determine the firm and secondary energy for the following set of data of average monthly flows of river over a year. [8]
- | Months                           | Jan | Feb | Mar | Apr | May | Jun | Jul  | Aug  | Sep  | Oct  | Nov  | Dec |
|----------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|------|-----|
| $Q$<br>( $\text{m}^3/\text{s}$ ) | 150 | 250 | 300 | 425 | 500 | 100 | 1250 | 1100 | 1000 | 1300 | 1600 | 500 |
12. Check the stability of concrete gravity dam against overturning and sliding. Consider  $\mu = 0.7$ ,  $\gamma_{\text{concrete}} = 24 \text{ kN/m}^3$ , average shear strength of material at the horizontal section ( $q$ ) =  $1400 \text{ kN/m}$ . [8]



13. What is the function of a spillway? Describe with sketches the vertical and radius gate use in spillway. [2+4]

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1. a) Define mass density, specific weight, specific volume and specific gravity. [2]
- b) A liquid compressed in a cylinder has a volume of  $3600 \text{ cm}^3$  at pressure  $4 \text{ MN/m}^2$  and a volume of  $3200 \text{ cm}^3$  at pressure  $8 \text{ MN/m}^2$ . What is bulk modulus of elasticity? [4]
2. A vertical rectangular gate  $4\text{m} \times 2\text{m}$  ( $4\text{ m}$  side being vertical) is hinged at a point  $10\text{ cm}$  below the centre of gravity of the gate. The depth of water is  $6\text{ m}$  above the bottom of the gate. What is horizontal force must be applied at the bottom of the gate to keep it in vertical position? [8]
3. Define the following and give one practical example for each i) steady and unsteady flow ii) laminar and turbulent flow [4]
4. Find the normal depth of flow in a triangular channel having longitudinal slope of  $0.0004$  and side slopes of  $1:1$  when it carries  $1 \text{ m}^3/\text{sec}$ , manning roughness coefficient ( $n$ ) =  $0.014$ . [8]
5. Compute the stream flow for the measurement data given below. [10]

Distance (m)	0	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6
Depth (m)	0	0.3	1.29	2.16	2.55	2.22	1.68	1.41	1.05	0.63	0.42	0
Velocity (m/s) at 0.2d	0	0.42	0.57	0.78	0.87	0.81	0.75	0.69	0.63	0.54	0.45	0
Velocity (m/s) at 0.8d	0	0.21	0.36	0.54	0.60	0.30	0.51	0.45	0.39	0.33	0.30	0

6. Mean monthly flow for a Nepalese river is given below, the net head of river  $150\text{m}$ , overall efficiency of  $85\%$ . Assume  $10\%$  of water of minimum flow is required to be left for environment and downstream user in the river. Determine the primary and secondary energy produced by the plant, if design discharge is set to  $950 \text{ m}^3/\text{s}$ . [10]

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Qm <sup>3</sup> /s	100	120	140	300	350	1800	2000	2520	2000	900	650	500

Assume any other date suitably if required.

7. a) What do you mean by a spillway? Briefly describe on ogee spillway. [4]
- b) A concrete gravity dam has maximum reservoir level  $250 \text{ m}$ , base level of dam  $200 \text{ m}$ , tail water elevation  $210 \text{ m}$ , base width of dam  $40 \text{ m}$ , location of drainage gallery  $10 \text{ m}$  from upstream face which may be assumed as vertical. Compute hydrostatic thrust and uplift force per unit length of dam at its base level. Assume  $50\%$  reduction in net seepage head at the location of the drainage gallery. [5+5]

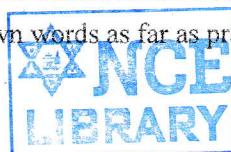
8. A conical draft tube having inlet and outlet diameters 1.5 m and 2.1 m discharges water at outlet with a velocity of 3 m/s. The total length of the draft tube is 7.5 m and 1.5 m of length of draft tube is immersed in water. If loss of head due to friction in draft tube is  $0.2 \times$  velocity head at the tube outlet, determine pressure head at inlet of the draft tube. Also find the efficiency of the draft tube. [6]
9. Why settling basin is essential in hydropower electric project in Nepal? Draw a layout plan and section of typical settling basin along with its design criteria. [3+3]
10. Describe the selection criteria of hydraulic turbines for hydroelectric power plants. [4]
11. Describe various types of spillways used in hydropower plants with neat sketches. [4]

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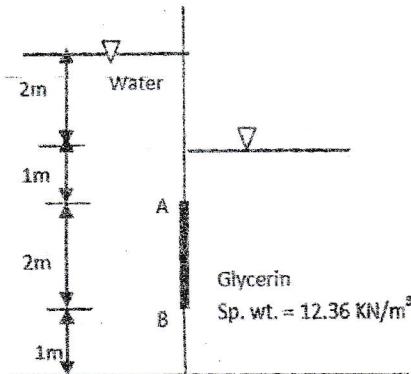
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- (4) 1. a) Classify the fluid flows with examples: (i) Laminar versus Turbulent (ii) Steady versus Unsteady. [2+2]
- (4) b) Discuss surface tension and Capillarity. [4]
2. Find the net hydrostatic force per unit width on rectangular panel AB in the figure given below and determine its line of action. [10]



- (10) 3. A pipe 5 cm diameter is 5 m long and carries a discharge of  $0.005 \text{ m}^3/\text{s}$ . Find the loss of head due to friction. The central 2 m length of the pipe is replaced by a pipe 7.5 cm diameter, the changes of section being sudden. Determine the loss of head due to these alternatives considering all losses. Take  $f = 0.01$  for all pipes and contraction loss coefficient = 0.5. [4+6]
4. At known distances from an initial point on the stream bank, the measured depth and velocity of a river are shown in table. Calculate the corresponding discharge at this location. [8]

Distance from initial point (m)	0	10	20	30	40	50	60	70	80	90	99
Depth (m)	0	1.0	1.5	2.0	2.5	3.0	3.5	3.0	2.0	1.5	0
Mean velocity (m/s)	0	0.6	0.8	1.0	1.2	1.4	1.6	1.3	1.0	0.5	0

5. Following table shows the mean monthly flow of a typical river of Nepal. Estimate the primary and secondary energies available in the river throughout the year. Assume 10% of minimum flow of the series has to be released for environmental flow to the downstream from the dam. Take overall efficiency of the plant is 80% and effective head is 155 m. [10]

Month	1	2	3	4	5	6	7	8	9	10	11	12
Discharge, m <sup>3</sup> /s	1150	1140	1450	1830	1700	1550	1150	1000	850	400	480	960

Note: The months are as per Nepalese calendar i.e 1 as Baishakh and so on.

6. A concrete dam of trapezoidal section is of height 50 m with upstream vertical face. Top width, base width and freeboard are 4.5 m, 42 m and 5 m respectively. Check the stability of the dam against (i) Overturning (ii) sliding (iii) Tension and (iv) Crushing. The unit weight of water is  $10 \text{ KN/m}^3$ , the unit weight of concrete is  $25 \text{ KN/m}^3$  and Crushing strength of the material  $10 \text{ kg/cm}^2$ . Take angle of internal friction ( $\phi=37^\circ$ ), uplift coefficient 0.8. Consider self-weight, hydraulic pressure and uplift pressure only. Mention your recommendation.

[8]

7. With considering turbulent effect, design a settling basin to remove the sediment size greater than 0.25 mm diameter. Assume design discharge of the basin is  $10 \text{ m}^3/\text{s}$  and trap efficiency as 95%.

[8]

8. What is the main propose of spillway? List out the different type of spillway used in hydropower projects.

[1+5]

9. a) Differentiate between impulse and reaction turbines with the help of their performance characteristics.

[4]

b) What is the purpose of governor in a turbine? How does a centrifugal pump works?

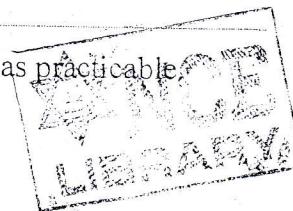
[4+4]

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(6)

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1. Classify the fluid flows with examples: (i) Compressible versus Incompressible  
(ii) Laminar versus Turbulent and (iii) Steady versus Unsteady. [2+2+2]
2. Define the following terms: [3×3]
  - i) Froude number
  - ii) Specific energy
  - iii) Best hydraulic section
3. A rectangular channel, 8 m wide and 1.5 m deep, has a slope of 0.001 in 1 and is lined with smooth concrete plaster. It is desired to enhance the discharge to a maximum by changing the dimensions of the channel but keeping the same amount of lining. Find the new dimensions and percentage increase in discharge. For smooth concrete plaster, take Manning's constant = 0.015. [10]
4. The data pertaining to a stream-gauging operation at a gauging site are given below. The rating equation of the current meter is  $v = (0.55 N + 0.04)m/s$ . Calculate the discharge in the stream. [8]
 

Dist from left edge (m)	0	1.0	4.0	7.0	10.0	11.0
Depth (m)	0	1.5	2.5	3.5	2.4	0
Revolution of current meter at 0.6d	0	40	60	120	125	0
Duration of observations (s)	0	100	100	150	150	0
5. Sketch the layout of hydropower scheme showing different components parts. [3]
6. What are the major sources of electric power generation? Discuss the relative merits and demerits of hydropower as compared to thermal power. [2+3]
7. Describe the forces that possibly acted to the gravity dam. Show them in neat and clean sketch. Describe the stability requirements of gravity dam. [9]
8. Differentiate between a Surge Tank and a Forebay. [4]
9. Explain the design principle and criteria of settling basin with neat sketches of basin and discuss the different component of the basin. [7]
10. Differentiate between Pelton turbine and Francis turbine with the help of their performance characteristics. [6]
11. What is meant by economical diameter of penstock pipe? Why is it necessary to work out in hydropower plant? [3+3]
12. In hydropower project the available river discharge is  $340m^3/s$  under the net head of 27.5 m. If the speed of the turbine is to be 166.7 rpm and overall efficiency is 88%. Determine the number of unit required if Kaplan turbine of specific speed 560 rpm in SI-unit is selected. [5]

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1. What factors should be considered in selecting a site for a stream gauging station? Describe briefly the procedure of using a current meter for measuring velocity of stream. [3+3]
2. State Bernoulli's equation. Mention the assumptions made. How is it modified while applying in real practice? [1+1+2]
3. A pipeline supplies  $0.09 \text{ m}^3/\text{s}$  water from a reservoir to a building. The pipe is 2 km long and 0.15 m diameter with friction factor 0.025. It is desired to increase the discharge by 25% by installing another pipeline having same friction factor in parallel with this over half the length. Recommend a suitable diameter of the pipe to be installed. [8]
4. What is meant by economical channel section? Prove that a triangular channel section will be most economical when each of its slopes is 1:1 and sloping sides makes an angle of  $45^\circ$  with vertical. [2+5]
5. A rectangular plate 0.6 m wide and 1.2 m deep lies within a water body such that its plane is inclined at  $40^\circ$  to the horizontal and the top edge is 0.70 m below the water surface. Determine the total pressure force on the plate and the location of the center of pressure. [8]
6. What are the functions of forebay? Describe briefly about layout of forebay on hydropower project with neat sketch. [2+3]
7. What is the flow duration curve? Describe in brief the parameters influencing planning of hydropower projects. [2+6]
8. a) Why draft tube is used in Francis turbine? How does a centrifugal pump works? Discuss. [3+3]
   
b) What is the significance of a governor in a turbine? [3]
9. What criterias do you consider while designing and laying out a hydraulic tunnel? Explain. [6]
10. Draw a typical layout of powerhouse with Francis turbine. How would you fix the appropriate dimension of the powerhouse? [2+3]
11. List out any five types of spillway used in hydropower projects in the dam reservoir system. Explain briefly the most suitably type of spillway in the context of Nepalese river site. [2+4]
12. What is an elementary profile of a gravity dam? What condition should be satisfied for such profile? Explain with mathematical expression. [8]

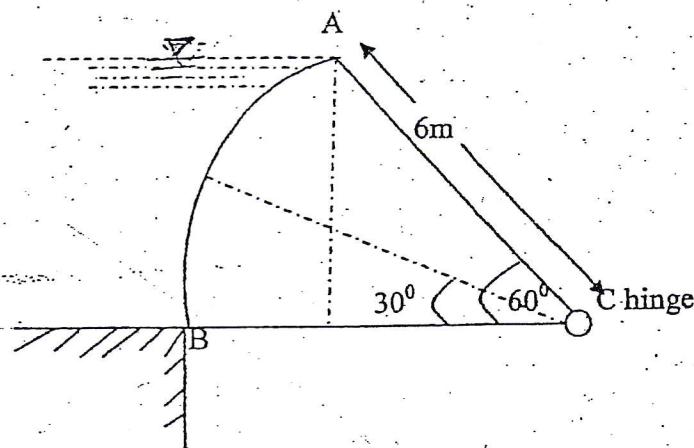
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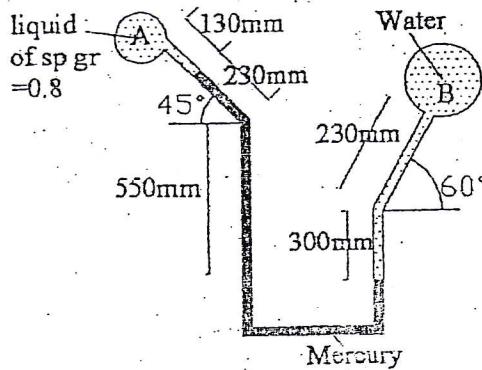
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1. The sector shown in figure below consists of a cylindrical surface of which AB is the trace, supported by a structural frame hinged at C the length of the gate is 4 m determine the magnitude and location of the horizontal and vertical component of the total hydrostatic pressure on the gate. [7]



2. What is water hammer and what are its effects? How the water hammer pressure is calculated for the gradual closure of the valve in the pipe? [3+4]
3. Find the pressure difference between the container A and B as shown in figure. [7]



4. How the discharge of a stream or river can be computed by slope area method. [6]
5. State Bernoulli's equation of motion along one dimensional streamline flow of an incompressible fluid. Also explain the significant of various energy terms with assumptions. [2+3]

6. Explain the level of studies involved in reconnaissance, prefeasibility and feasibility studies of the hydro power project. [8]
7. Explain the hydraulic design criteria of a settling basin. [5]
8. Design a Pelton turbine with the following data: [9]

Design discharge =  $2 \text{ m}^3/\text{s}$

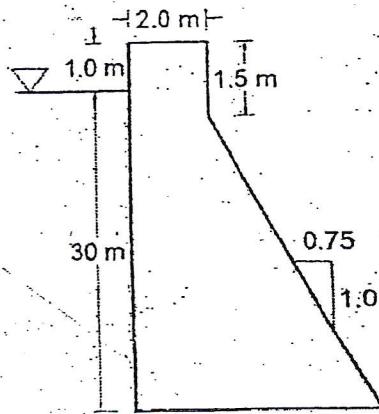
Net head =  $605 \text{ m}$

Overall efficiency =  $87\%$

Specific speed =  $100$

Assume the ratios and coefficients from their standard range.

9. Check safety against sliding and overturning for the gravity dam shown in figure. Assume, unit weight of water =  $9.81 \text{ kN/m}^3$ , unit weight of concrete =  $24 \text{ kN/m}^3$ , angle of internal friction  $\phi = 37^\circ$ , uplift coefficient =  $80\%$ . Consider self-weight, hydrostatic pressure and uplift pressure only. Mention your recommendations. [9]



10. Explain with neat sketch, different types of intakes and its suitability in hydropower projects. [5]
11. Define cavitation. Write about cavitation phenomenon over the spillway. [2+4]
12. What is the purpose of governor? Write about the governing of Francis Turbine. [2+4]

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23 TRIBHUVAN UNIVERSITY  
 INSTITUTE OF ENGINEERING  
**Examination Control Division**  
 2070 Bhadra

Exam.		Regular	
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject:** - Hydropower (CE660)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



1. Define the terms specific gravity, and specific weight. Differentiate between Newtonian and Non Newtonian fluid showing diagram of variations of shear stress with velocity gradient. [2+4]
2. What do you mean by a channel of hydraulically best section? Shows that the hydraulic mean depth for a trapezoidal channel is half the depth of flow. [2+6]
3. Two reservoirs are connected by a pipe line which is 20 cm in diameter for the first 5 m and 30 cm in diameter for the remaining 20 m. The entrance and exit are sharp and change of section is sudden. If the water surface in the upper reservoir is 6 m, above that in the lower reservoir, calculate head losses and rate of flow. Take  $f = 0.01$  for all cases. [8]
4. What is the use of manometer? Show the working principle of inverted manometer with neat sketch. [2+4]
5. Define with application of stage discharge curve in hydropower project. [6]
6. What is the function of forebay? Describe the types of surge tank. [2+3]
7. Estimate primary and secondary energy from the data given below. [10]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flow (m <sup>3</sup> /s)	30	28	24	29	18	37	65	90	74	56	42	39

Net head available = 102 m

Discharge capacity = 55 m<sup>3</sup>/s

Overall efficiency = 76%

8. How does a centrifugal pump work? Mention the parameter that govern dimensioning of power house. [3+3]
9. Mention with neat sketches different types of spillway gates. [6]
10. A hydropower plant was designed for 150 m<sup>3</sup>/s under the head of 46 m. If the speed of the turbine is to be 165 rpm and overall efficiency is 86.5%, determine the number of units required and output of each unit, if the propeller turbine of specific speed 234 is selected. [8]
11. Determine the uplift pressure force on a gravity dam of 40m height, 10 m top width with u/s face vertical and the base width = 30 m. The tail water depth is 5 m and the free board is 3 m. What will be the uplift pressure force when there is a drainage gallery at a distance of 6 m from u/s face? [3+3]
12. Explain different types of intake used in hydropower projects with neat sketch. [5]

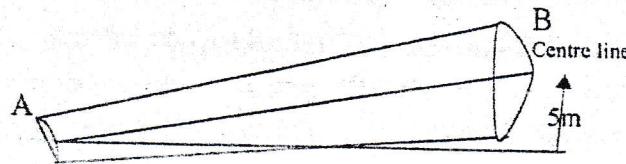
Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject:** - Hydropower (CE660)

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1. How do you measure difference of pressure between any two points in a pipe? Explain with neat sketch and mathematical expression. [6]
2. Calculate dimensions of a most efficient trapezoidal channel section having side slopes 3H:4V with  $n = 0.012$  consider bed slope 1 in 2000 which carries water at a velocity of 0.50 m/s. [6]
3. An isosceles triangle plate of base 4 m and altitude 6 m is immersed vertically in water. Its axis of symmetry is parallel to the free surface and at a depth of 6 m from the free water surface. Calculate the magnitude and location of the total pressure force. [6]
4. A pipe line (AB) conveying oil (specific gravity = 0.90) has diameter 0.05 m and length 100 m. The discharge is 120 liter per second. Find the loss of head and the direction of flow. [7]



5. Define cavitations erosion in spillway? Explain with neat sketch of different types of energy dissipator used on hydropower plant. [2+4]
  6. What are the objectives of the provision of draft tube for the reaction turbine? Write notes on the working principal of governors. [2+3]
  7. How peak flow is estimated by using compound method and Chamber's assumption? [2+3]
  8. Discuss with neat sketch the force acting on a gravity dam. [6]
  9. What criterias do you consider while designing and laying out a hydraulic tunnel. Explain. [3+3]
  10. Design a pelton turbine with following data:  
Overall efficiency = 87%  
Discharge ( $Q_d$ ) =  $1.8 \text{ m}^3/\text{s}$   
Net head ( $H$ ) = 605 m [8]
  11. From the following data of flow at a given site for an average year compute and draw a power duration curve. Assume an average net available head of 100 m and a combined turbine generator efficiency of 89%. Determine the primary and secondary energy available during a year if the plant capacity is fixed at power corresponding to the flow available for 45% of time. [10]
- | Flow | 900 | 600 | 500 | 450 | 400 | 360 | 340 | 300 | 280 | 200 | 140 | 100 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| time | 1   | 10  | 20  | 30  | 40  | 50  | 60  | 70  | 80  | 90  | 93  | 100 |
12. What do you understand by economical diameter of penstock pipe? Why it is necessary to remove the sediment of flow in hydropower project? [3+3]