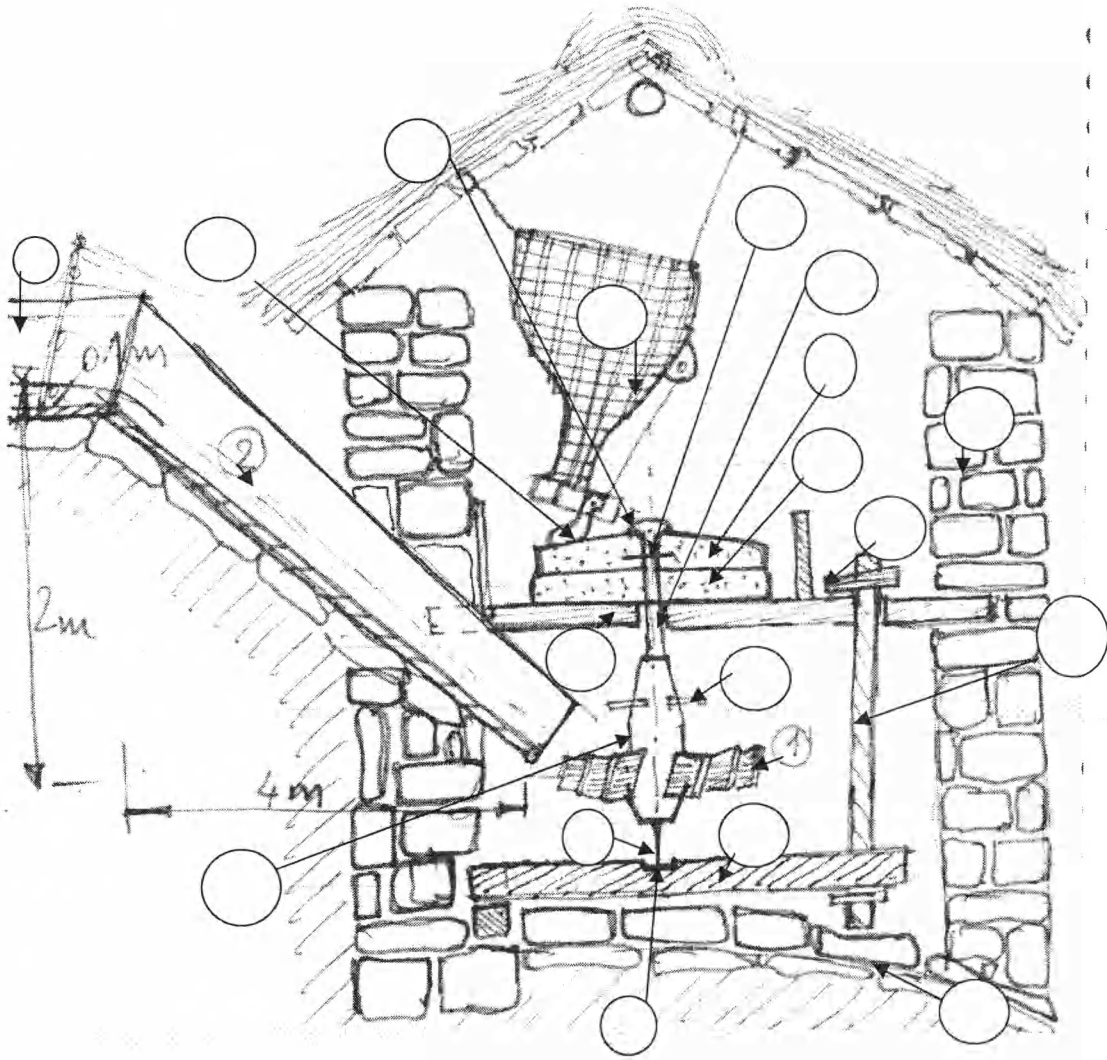


6. Place the components number on the picture appropriately.
- | | |
|--|--|
| [1] Traditional water wheel (vertical) | [2] Chute delivering the water to the wheel |
| [3] Grain Basket (Hooper) | [4] Bird (vibrator) to keep the grain moving |
| [5] The hole for grain to pass through the grinder | [6] Upper and lower grinder made of stone (rotor) |
| [7] Rynd (Forged metal piece to connect the upper grinding stone with the shaft) | [8] Lower grinding stone (stator) |
| [9] Shaft (Metal) | [10] Splash protector |
| [11] Hub (wood or metal) thick shaft | [12] Pinion (metal takkar) |
| [13] The metal base (Chakati) | [14] Lever, the lifting device to adjust the gap between the grinding stones |
| [15] Wedge for adjusting the gap | [16] Floor |
| [17] Tailrace | [18] Canal |



7. In the selection of a turbine or a pump (in general a hydraulic machine), a concept of specific speed has been introduced. This concept allowed engineers to test the performance of a large hydraulic machine in a small model in the laboratory. What is the physical meaning of the specific speed if the discharge is taken as the basis for it?
- [] It is the speed of a hydraulic machine that produces a unit power under a unit net head.
- [] It is the speed of a hydraulic machine that operates under a unit net head with a unit discharge.
- [] It is the speed of a fictive hydraulic machine that produces a unit power under a unit net head.
- [] It is the speed of a fictive hydraulic machine that operates under a unit net head with a unit discharge.
8. In which of the following Acts of Government of Nepal, it is expedient to have the water supply precedes the hydropower development?
- [] Water Resources Act 1992
- [] Electricity Act
- [] Foreign investment and technology transfer Act
- [] Environmental Protection Act

19. Looking at the sequence of the longitudinal profile of a river, the river may be zoned as an upper course, middle course, lower course, and estuary. Show qualitatively, where will be the equilibrium state of sediment transport occur?

- In between middle course and lower course In between lower course and estuary
 In between upper course and middle course In the middle course

20. What type of power plant scheme is this Sketch (name in blank box)? Put the number of the components in the circles below.

- | | | |
|--------------------------|------|------------------|
| [.....] | [1] | River course |
| [2] Retaining Weir | [3] | Side intake |
| [4] Desanding basin | [5] | Headrace channel |
| [6] Peaking pond | [7] | Forebay |
| [8] Powerhouse | [9] | Tailrace channel |
| [10] Bridge | [11] | Flushing channel |
| [12] Upstream embankment | [13] | Penstock |

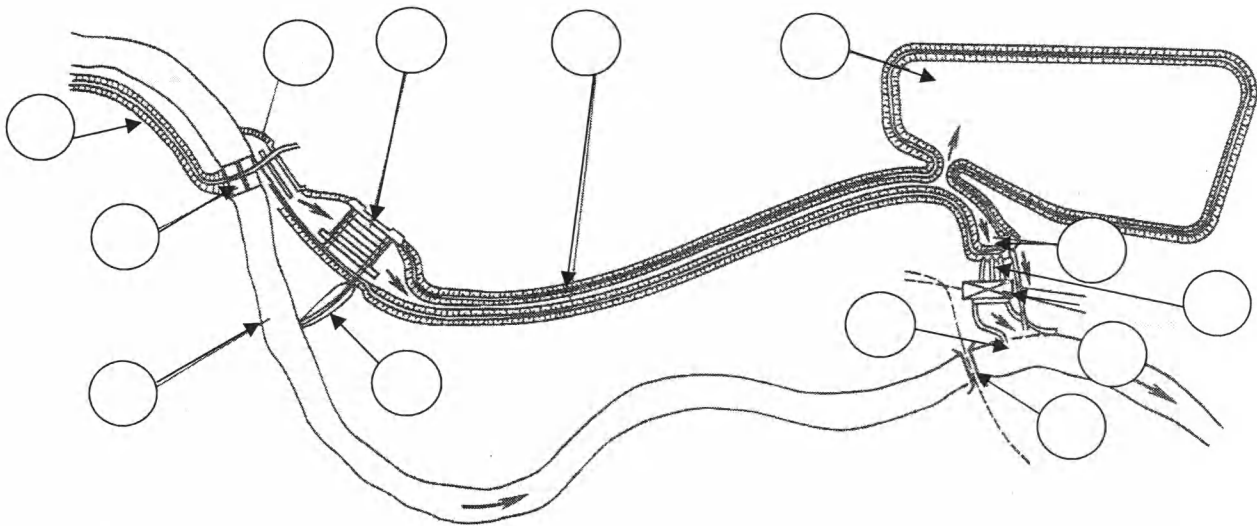




Table 1: Formulae List: Hydropower (assume appropriately if any missing data found)

$S = \frac{1}{k_1} \left(\frac{t+a}{a} \right) \frac{Q}{v_0} \frac{1}{\sin \alpha}$ $h_r = k_s \left(\frac{t}{a} \right)^{\frac{4}{3}} \frac{v^2}{2g} \sin \alpha$ $h_i = k \frac{v^2}{2g}$	$Q = AC \sqrt{2g(NWL - TWL)}$ $Q = \frac{2}{3} c \mu b L \sqrt{2gh}$ $C = 0.6 \frac{a}{d} \cos^{\frac{3}{2}} \beta$ $h = \frac{2}{3} h_E \chi$
$P_{\max/\min} = \frac{\sum V}{B} \left[1 \pm \frac{6e}{B} \right]$ $\bar{x} = \frac{\sum M}{\sum V}, e = \bar{x} - \frac{B}{2}$ $F_{\text{sliding}} = \frac{cB + \sum V \tan \phi}{\sum H}$	$Q = Av$ $v = \frac{1}{n} R^{2/3} S^{1/2} \quad f_s = 1.76d^{1/2}$ $A = By + zy^2$ $P = B + 2y\sqrt{1+z^2}$ $R = \frac{A}{P} \quad P = 4.75Q^{1/2}$
$v_{\text{fall}} = \sqrt{0.33(s-1)gd}$ $v_{\text{permissible}} = a\sqrt{d}$ $a = 36; d > 1mm \quad L = f \left(H \frac{v}{w - u_*} \right)$ $a = 44; 0.1 \leq d \leq 1mm$ $a = 51; d < 0.1mm$ $f = \text{safety factor} = 1.2 \text{ to } 1.5$ $u_* = \sqrt{gRS_e}$ $S_e = \left(\frac{Q}{nAR^{2/3}} \right)^{1/2}$ $\sigma_c = 0.625 \left(\frac{n_s}{380.78} \right)^2 \text{ for Francis Turbine}$ <p>Setting of the turbine $H_s = (H_a - H_v) - \sigma_s H_n$</p>	$n_g = n_{\text{syn}} \frac{\sqrt{Q}}{h_f^{0.75}} \text{ [min}^{-1}\text{]}$ $n_{\text{syn}} = \frac{60 * f}{P} \text{ [min}^{-1}\text{]}$ $n_s = \frac{2400}{\sqrt{H}} \text{ rpm for Francis Turbine}$ $D = \frac{84.6 \phi H}{n_{\text{syn}}} \text{ m}$ <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 5px auto;"> $\phi = 0.0197 n_s^{2/3} + 0.025$ </div> $n_s = \frac{n_{\text{syn}} \sqrt{P} \text{ [kW]}}{H_n^{5/4}}$
<p>submergence head $S = 1.5 \frac{v^2}{2g}$</p> <p>vortex free criteria</p> $\frac{S}{v\sqrt{d}} > 0.5$	$\lambda - 0.005 \left[1 + \left(\frac{2000ks}{D} + 10^6 / \text{Re} \right)^{1/3} \right]$ $\frac{1}{\sqrt{\lambda}} = -2 \log \left(\frac{k_s}{3.7D} + \frac{5.1286}{\text{Re}^{0.89}} \right)$
$h_{\text{dyn}} = (a*v) T_R / (g*T_s)$ $T_s = \frac{QL}{gH}$	$A_{\text{surge shaft}} = \frac{v_0^2 A_l L_l}{2gP_0 H_0}$ $h_f = \frac{flv^2}{2gD}$
$t = \frac{pR}{\sigma_{st} \eta_j - 0.6p} + 0.15(\text{cm})$ $v_{\text{opt}} = 0.125 \sqrt{2gH}$ $D = 0.52 H^{-0.17} (P/H)^{0.43}$ $\sigma_{st} = 1200 \text{ kg/cm}^2$	$\text{Generator rating} = 1.3 * \frac{\text{Turbine rating (kW)}}{A * B * C * D} \text{ [kVA]}$
$C_p = \sqrt{\frac{K}{1 + \frac{D-K}{v^2 E}}} \text{ m/s}$ $t = \frac{P_u D}{2\sigma} \text{ mm}$ $h_f = \frac{fLv^2}{2gD} \text{ m}$ $T_c = 2 \times (L/Vc)$	$D_c = 0.62 \times \frac{P^{1.85}}{H^{2.85}} \text{ [m]}$ $V_{\text{eco}} = 0.125 \sqrt{2gH} \text{ [m/s]}$ $Z_{\text{max}} = v_0 \text{Sqrt}(L_T A_T / (g A_{ST})) \text{ [m]}$ $P_o = h_f / Z_{\text{max}} \text{ [-]}$ $hp = C_p * v_p / g \text{ [-]}$ $Z_{\text{max, US}} = Z_{\text{max}} (1 - 2/3 P_o + 1/9 * P_o^2) \text{ [m]}$ $Z_{\text{max, DS}} = Z_{\text{max}} (-1 + 2 P_o) \text{ [m]}$ $T = 2\pi * \text{Sqrt}(L_T A_{ST} / (g A_T)) \text{ [s]}$

$Q = Av$ $v = \frac{1}{n} R^{2/3} S^{1/2}$ $A = By + zy^2$ $P = B + 2y\sqrt{1+z^2}$ $R = \frac{A}{P}$	$s = \frac{1 + aQ_i}{k_1 a v_o \sin \alpha}$ <p>K_1-coefficient related to the partial clogging of the screen</p> <ul style="list-style-type: none"> For no automatic raker = 0.20 to 0.30 For automatic raker with hourly operation = 0.4 to 0.6 For automatic raker with differential pressure sensor = 0.8 to 0.85 																																
$h_f = k \left(\frac{t}{a} \right)^{5/2} \frac{v^2}{2g} \sin \alpha$ <p>Where; h_f- loss of head through racks, m t- the thickness of rack bars, mm a-clear distance (spacing) between bars, mm v- velocity of flow through the trashrack, m/s α-angle of bar inclination to the horizontal k-factor depending on bar shape</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  $k=2.42$ </div> <div style="text-align: center;">  $k=1.83$ </div> </div>	$h_z = \xi \frac{v_n^2}{2g}$ <p>v_n-normal velocity through the orifice $\xi = \xi_s + \xi_a$</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Shape</th> <th>ξ_s</th> <th>Cone angle</th> <th>ξ_a</th> </tr> </thead> <tbody> <tr> <td>Bell mouth</td> <td>0.03 to 0.05</td> <td>30°</td> <td>0.002</td> </tr> <tr> <td>Slightly rounded</td> <td>0.12 to 0.25</td> <td>45°</td> <td>0.04</td> </tr> <tr> <td>Sharp cornered</td> <td>0.5</td> <td>60°</td> <td>0.07</td> </tr> </tbody> </table>	Shape	ξ_s	Cone angle	ξ_a	Bell mouth	0.03 to 0.05	30°	0.002	Slightly rounded	0.12 to 0.25	45°	0.04	Sharp cornered	0.5	60°	0.07																
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$Q_A = \frac{2}{3} c_L b L \sqrt{2gh}$ <p>c-correction factor for submerged over-fall $c = 0.5 \frac{a}{d} \cos^{1.5} \beta$</p> <p>Where a-internal width between bars d-center to center distance between bars</p>	$h = \frac{2}{3} \chi h_z$ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>β</th> <th>χ</th> <th>β</th> <th>χ</th> </tr> </thead> <tbody> <tr> <td>0°</td> <td>1.00</td> <td>14°</td> <td>0.899</td> </tr> <tr> <td>2°</td> <td>0.980</td> <td>16°</td> <td>0.865</td> </tr> <tr> <td>4°</td> <td>0.961</td> <td>18°</td> <td>0.851</td> </tr> <tr> <td>6°</td> <td>0.944</td> <td>20°</td> <td>0.837</td> </tr> <tr> <td>8°</td> <td>0.927</td> <td>22°</td> <td>0.825</td> </tr> <tr> <td>10°</td> <td>0.910</td> <td>24°</td> <td>0.812</td> </tr> <tr> <td>12°</td> <td>0.894</td> <td>26°</td> <td>0.800</td> </tr> </tbody> </table>	β	χ	β	χ	0°	1.00	14°	0.899	2°	0.980	16°	0.865	4°	0.961	18°	0.851	6°	0.944	20°	0.837	8°	0.927	22°	0.825	10°	0.910	24°	0.812	12°	0.894	26°	0.800
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$h = \frac{b_p - b_b}{c_p - c_b} \text{ [hour]}$ <p>Where h- duration of peak plant operation b_p-cost of power for peak plant b_b-cost of power for the base plant c_p-cost of energy for peak plant c_b-cost of energy for the base plant</p>	<p>Stored Energy in a reservoir $E_{st} = 1/(3.6 \times 10^6) * g * \rho_w * V * h_s$ [kWh] Where, h_s is head over tailrace up to the center of gravity of the reservoir</p>																																
<p>submergence head $S = 1.5 \frac{v^2}{2g}$</p> <p>vortex free criteria</p> $\frac{S}{v\sqrt{d}} > 0.5$	$Q_{spillway} = \frac{2}{3} C_d \sqrt{2g} . b . H^{3/2}$																																
<p>Area below 3000 m is used for the estimation of flood of various return periods</p> $Q_{2 \text{ daily}} = 0.8154 \times (A \text{ below } 3000 \text{ m} + 1)^{0.9527}$ $Q_{2 \text{ inst}} = 1.8767 \times (A \text{ below } 3000 \text{ m} + 1)^{0.8783}$ $Q_{100 \text{ daily}} = 4.144 \times (A \text{ below } 3000 \text{ m} + 1)^{0.8448}$ $Q_{100 \text{ inst}} = 14.630 \times (A \text{ below } 3000 \text{ m} + 1)^{0.7343}$ <p>Flood peak discharge, Q_F, for any other return periods can be calculated using:</p> $Q_F = e^{\left(\frac{\ln Q_2 + S \sigma}{\ln Q_F} \right)}$ <p>Where:</p> $\sigma_{\ln Q_F} = \ln(Q_{100}/Q_2)/2.326$	<p>Table: Standard normal variants S for floods for the chosen return period</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Return period (T) (yrs)</th> <th>Standard normal variant (S)</th> </tr> </thead> <tbody> <tr> <td>2</td> <td>0</td> </tr> <tr> <td>5</td> <td>0.842</td> </tr> <tr> <td>10</td> <td>1.282</td> </tr> <tr> <td>20</td> <td>1.645</td> </tr> <tr> <td>50</td> <td>2.054</td> </tr> <tr> <td>100</td> <td>2.326</td> </tr> </tbody> </table> <p>$Q = C \times (\text{Area of Basin})^{A1} \times (\text{Area below } 5000\text{m} + 1)^{A2} \times (\text{mean monsoon precipitation})^{A3}$</p>	Return period (T) (yrs)	Standard normal variant (S)	2	0	5	0.842	10	1.282	20	1.645	50	2.054	100	2.326																		
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Stream Flow using salt dilution method

$Q = M \times k/A$, where

- Q = flow in lit/sec
- M = mass of the dried salt in mg (i.e. 10^{-6} kg).
- k = the salt constant in (μ S)/(mg/liter).
- A is the effective area under the graph of conductivity versus time, after excluding the area due to base conductivity. The units for the area under the graph is $\text{sec} \times \mu$ S. The area is determined as follows:

Effective Area (A) = $(\sum \mu - n r \times \mu_{\text{baseline}}) \times dt$

MIP mean monthly calculations:

Corrected coefficient and mid-month discharges (K_{March}) for any Region:

Since the measured date of March 23 lies in between March 15th and April 15th,

$$K_{\text{March}} = 1.38$$

$$K_{\text{April}} = 1.00$$

$$K_{C_{\text{March}}} = K_{\text{March}} + (K_{\text{April}} - K_{\text{March}}) \times (\text{Date} - 15) / 30$$

$$Q_{\text{March}} = Q_{\text{measured}} \times K_{\text{March}} / K_{C_{\text{March}}}$$

$$Q_{\text{April}} = Q_{\text{March}} / K_{\text{March}}$$

Other mid-monthly discharges are calculated similarly to the discharge calculation for the month of May.

$$Q_{\text{May}} = Q_{\text{April}} \times K_{\text{May}}$$

Fig 3 shows an example of interpolation of April 1, 15 and 30 data

- In $Q_{0\%} = -3.5346 + 0.9398 \cdot \ln(\text{Area below } 5000 \text{ m} + 1) + 0.3739 \cdot \ln(\text{Monsoon wetness index})$
- In $Q_{5\%} = -3.4978 + 0.9814 \cdot \ln(\text{Area below } 5000 \text{ m} + 1) + 0.2670 \cdot \ln(\text{Monsoon wetness index})$
- In $Q_{20\%} = -5.4357 + 0.9824 \cdot \ln(\text{Area of basin}) + 0.4408 \cdot \ln(\text{Monsoon wetness index})$
- In $Q_{60\%} = -6.4846 + 1.0004 \cdot \ln(\text{Area of basin}) + 0.3016 \cdot \ln(\text{Monsoon wetness index})$
- In $Q_{80\%} = -4.8508 + 1.0375 \cdot \ln(\text{Area of basin}) + 0.3016 \cdot \ln(\text{Area below } 5000 \text{ m} + 1)$
- In $Q_{95\%} = -5.4716 + 1.0776 \cdot \ln(\text{Area below } 5000 \text{ m} + 1)$
- $Q_{100\%} = -0.09892 + 0.08149 \cdot (\text{Area below } 5000 \text{ m} + 1)$

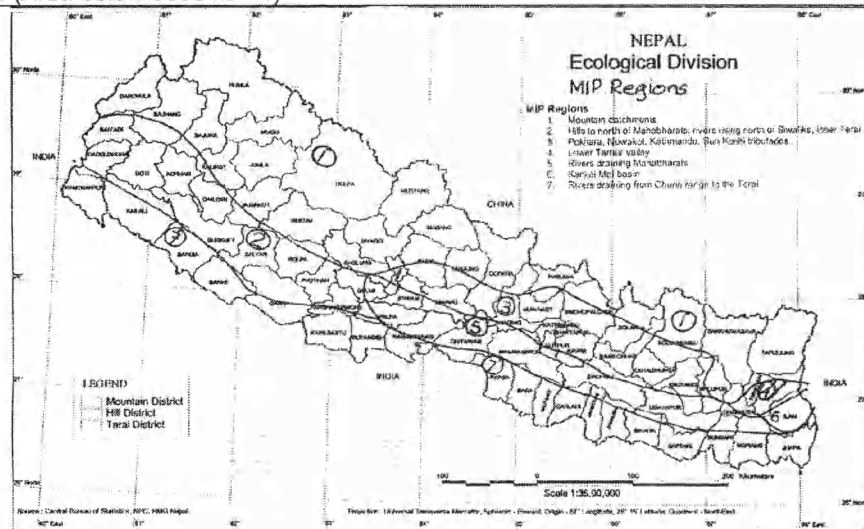


Figure 2: MIP Regions

Table 3 MIP regional monthly coefficients

Month	Regions							Month	Regions						
	1	2	3	4	5	6	7		1	2	3	4	5	6	7
J	2.4	2.24	2.71	2.59	2.42	2.03	3.30	J	14.5	18.18	13.54	6.89	11.21	24.32	14.00
F	1.8	1.7	1.88	1.88	1.82	1.62	2.20	A	25.0	27.27	25.0	27.27	13.94	33.78	35.00
M	1.3	1.33	1.38	1.38	1.36	1.27	1.40	S	16.5	20.91	20.83	20.91	10	27.03	24.00
A	1.0	1.00	1.00	1.00	1.00	1.00	1.00	O	8.00	9.09	10.42	6.89	6.52	6.08	12.00
M	2.6	1.21	1.88	2.19	0.91	2.57	3.50	N	4.1	3.94	5.00	5.00	4.55	3.38	7.50
J	6.0	7.27	3.13	3.75	2.73	6.08	6.00	D	3.1	3.03	3.75	3.44	3.33	2.57	5.00

Table 4 Coefficients for Mean Monthly Flow in the WECS Method

Month	Coefficient					Month	Coefficient				
	C	A1	A2	A3	Q		C	A1	A2	A3	Q
J	0.01423	0	0.9777	0		J	0.02123	0	1.0093	0.2523	
F	0.01219	0	0.9766	0		A	0.02548	0	0.9963	0.2620	
M	0.009988	0	0.9948	0		S	0.01677	0	0.9894	0.2878	
A	0.007974	0	1.0435	0		O	0.009724	0	0.9880	0.2508	
M	0.008434	0	1.0898	0		N	0.001760	0.9605	0	0.3910	
J	0.006943	0.9968	0	0.2610		D	0.001485	0.9536	0	0.3607	

Fig 3: Example of interpolation of April 1, 15 and 30 data

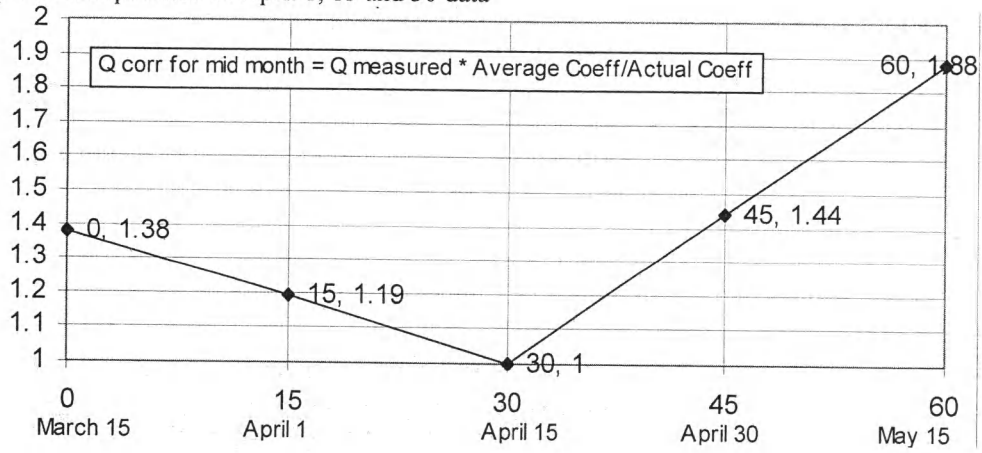
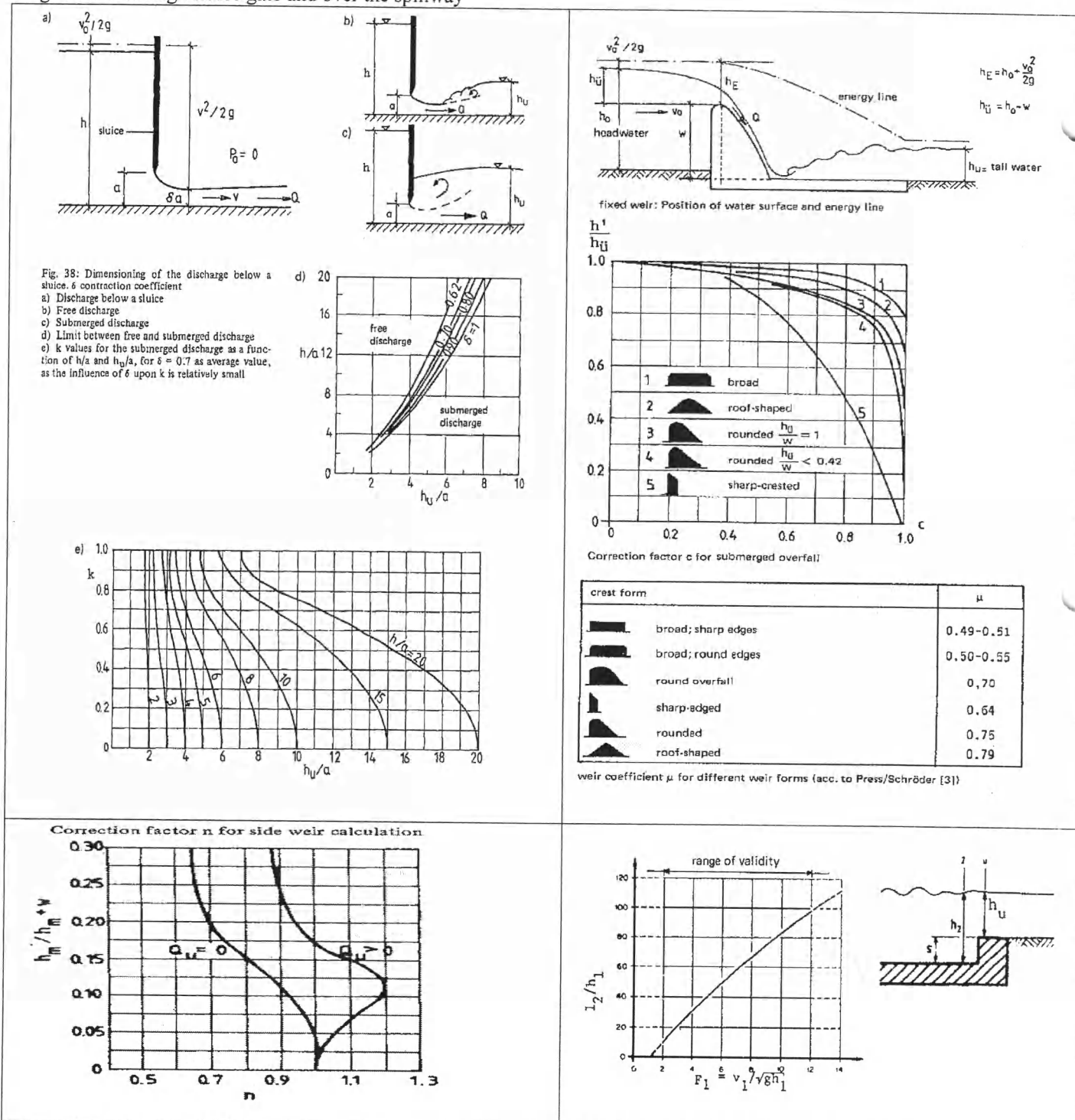


Fig 4: Flow through sluice gate and over the spillway



KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Marks Scored:

Level : B.E.
Year : IV
Time : 2 hrs. 30 mins.

FEB 25 2019
Course : CIEG 406
Semester : I
F. M. : 40

SECTION "B"
(Short answer questions)
[14 marks]

Attempt *ONLY TWO*. The question no. 1 is compulsory.

1. Describing your candid opinion on MOEWRI's White Paper in general, give short-term, medium-term and long-term measures for transforming the slogans Every House: Energy House through solar PV as well as other renewable energy technology and नेपालको पानी : जनताको लगानी - हरेक नेपाली : बिधुतको शेरधनी through जलबिधुत आयोजना (400-600 words) [8]
2. Explain with the sketch of a Bath-tub curve, the necessity to rehabilitate and modernize an existing hydropower plant? List out the hydropower plants built in Nepal before 1980 that need to be rehabilitated and modernized. [4+2=6]
3. With a scheme or chart, give the basic approach for a systematic appraisal of Hydropower Project. What is an EOI in the hydropower development process and describe in brief the documents that must be submitted in the prescribed 3 types of forms? [3+3=6]
4. Write an essay on any one of the following topic in which you were involved in the Seminar II preparation (200-300 words): [6]
 - Upper Tamakoshi Hydropower Project in Nepal (456 MW)
 - Tarbela Hydropower Project in Pakistan (6,298 MW)
 - Sardar Sarovar Hydropower Project in India (1450 MW)
 - Upper Karnali Hydropower Project (900MW)
 - Pancheshwor Multipurpose Hydropower Project (3240 MW)
 - Three Gorges Hydropower Project in China (21000 MW)
 - Budhigandaki Hydropower 1200 MW
 - Arun III HEP (900 MW)
 - Karnali-Chisapani HEP (10800 MW)

SECTION "C"
(Long answer questions)
[26 marks]

Attempt *ONLY TWO*. The question no. 5 is compulsory. Assume logically necessary data appropriately if missing.

5. Water is delivered from the upper impounding reservoir through a low-pressure tunnel and high-pressure penstocks to the three turbine-generator units using a trifurcation in a high-head hydropower plant. The tunnel and penstock are separated by a simple surge chamber of 10 m diameter to cope with the transient in waterways. Due to ecological reason, only 60 % of the maximum reservoir storage of $30 \times 10^6 \text{ m}^3$ can be utilized continuously for 4 hours during the peak-demand time period. The volume of the lower reservoir, which is an artificial lake, is only $0.8 \times 10^6 \text{ m}^3$ to store incoming discharge from its rivers. The following data for the so-called pump-stored hydropower plant are available: [16]

Given	Symbol	Value	Unit	
Elevation of the Impounding Reservoir water level	HWL	1600	m amsl	
Elevation of the downstream reservoir water level		1000	m amsl	
The total volume of Impounding Reservoir (IR)	V_{IR}	25×10^6	m^3	
Period of daily peaking	T_{TM}	4	hrs	
Length of low-pressure tunnel	L_T	0.6	km	
The diameter of the low-pressure tunnel	D_T	3	m	
Friction factor of the low-pressure tunnel	f_T	0.025	-	
Number of High-pressure Penstock	n	1	Nos.	

Length of Penstock	L_P	100	m	
The diameter of steel Penstock	D_P	1.5	m	
Friction factor of Penstock material	F_P	0.016	-	
Turbine efficiency	η_{TM}	95	%	
The efficiency of the Generator (Generator with 16 poles, 50 Hz)	η_{GTM}	98	%	
Barometric pressure	BP	10.3	m of WC	
Thoma's Cavitation coefficient	σ_{TH}	0.043^* $(n_s/100)^2$	-	

Table 2: Calculation table (use this table and attached to your answer sheet)

Determine:				Marks
(a) Draw a neat profile of the project components and show all necessary descriptions with dimensions				2
(b) Determine the maximum power output from the installation for 6 hrs	P		MW	0.5
(c) Estimate the specific speeds and specify the type of turbine. Give the fundamental difference between these two specific speeds.	n_s		rpm	0.5
	n_q			
(d) Determine the safe turbine setting level relative to the downstream reservoir water level.	H_s		m amsl	0.5
(e) Determine the position of the centerline of runner for vertical turbine setting.	H_T		m amsl	0.5
(f) Estimate:				
• The maximum upsurge and down surge in the surge chamber for a sudden rejection of one unit; and	$Z_{max, US}$		m amsl	0.5 + 0.5
	$Z_{max, DS}$			
• The maximum down surge for sudden acceptance of demand on one unit. And the time of oscillation	$Z_{max, DS}$		m amsl	0.5+0.5
	T		s	
(g) Determine the power and energy from the powerhouse throughout a year of operation with 60% of Load Factor.	P		MW	0.5+0.5
	E		MWh	
(h) Determine the extra volume of the lower reservoir that is needed to store the water during turbine mode. Give your final remarks on what needs to be done if the reservoir volume is not enough.	V_{ELR}		m^3	0.5+0.5

6. A multipurpose reservoir type hydropower project uses a given river with mean annual river discharge (Q_{Rmean}) for irrigation (Q_{Irr}), water-supply (Q_{WS}) and power production (Q_{PP}). To maintain the ecological regime of the river downstream, an environmental flow (Q_{Env}) shall be released which equals 5% of Q_{Rmean} as well as a spillway that discharges a flow through a fish ladder, (Q_{Fish}), which is 10% of Q_{Rmean} is also envisaged. Out of total electricity generated, 15% will be used for pumping water for irrigation and 25 % for water supply through the same canal. The canal is located at a head of H_{Can} m from the reservoir water level. The rest of the electricity will feed the grid (P_{Grid}). Take total efficiency of hydropower = η_T , efficiency of pump = η_{Pump} . The tailrace water level power plant is located at the toe of H_{Dam} m high dam. All losses shall be ignored. [10]

Solving the equation, determine:

- a unified equation for capacities and discharges if H_{Dam} = half of H_{Can} and η_T = Three-fourth of η_{Pump} .
- the discharges for irrigation (Q_{Irr}) and water supply (Q_{WS}) that shall be pumped.
- the installed capacity (P_{Inst}) of the power plant.
- the installed capacity of irrigation pump ($P_{Pump, Irr}$) and water supply pump ($P_{Pump, WS}$).
- Provide a neat sketch of the components of the multi-purpose power project.

7. Describe WECS (HYDEST) and MIP Methods and compare differences between these two methods. Use these two methods to determine the hydrological parameters (hydrographs and flow-duration curves) for a small hydropower plant and prepare a comparative graph if the following data are available: [10]

- a) Hydrological region: 4 (see Table 3 for data)
- b) Basin Area: 340 km^2
- c) The area below 5000 mamsl: 200 km^2
- d) The area below 3000 mamsl: 100 km^2
- e) The month of Gauging: March 23 (see fig 3 for interpolation)
- f) Flow measured using the wading method: 2.0 m^3/s
- g) Other required data and formula are given in the formula sheet in annex

Determine:

- a) Monsoon Wetness Index (MWI) [1]
- b) Estimate the daily and instantaneous floods of various return periods [2]
- c) Determine the average monthly flow using MIP and WECS Methods [2]
- d) Determine the flow duration using the WECS Method [2]
- e) Plot the hydrographs and flow duration curves using both MIP and WECS Methods and analyze the difference between them. [3]

8. As per the MGSP guidelines, at least one set of discharge measurement at the proposed intake site should be carried out between November and May. The discharge calculation spreadsheet presented in the Design Aids can handle up to four sets of data and the individual, as well as the average discharges, are presented as outputs for 3 sets. The input parameters required for discharge measurement calculation are presented in Table 3. The first set of field readings are presented in Table 4. Table 5 gives the other inputs for calculation. By completing the highlighted column in Table 4, determine the Number of readings (nr) Baseline conductivity (μ_{baseline}) Sum of readings ($\Sigma\mu$) for the Set 1 and calculate the time intervals (dt), effective area (A) and discharges (Q) for all three sets and give the average discharge in Table 5. Plot the output curves. The marks are uniformly distributed. [10]

Table 3: Input for Salt Dilution Method

SN	Input	Input	Unit
1	Project	Upper Jogmai, Ilam	
2	Conductivity Meter	HANNA Instruments HI 933000	
3	Date	12-Dec-10	
4	Type of Salt	Aayoo Nun	
5	Conductivity Constant (k)	1.8 at 15°C	[-]
6	Water temp	15°	C
7	Time Intervals (dt)	5	sec
8	Weights of salt for sets 1 to 3 (g)	400, 1580 and 1795	[g]
9	Readings (μ & μ_{baseline}) for sets 1 to 3	Presented in Table 4 for Set 1 and for Set 2 and 3 in Table 5	

Table 4: Input for Salt Dilution Method for Set 1

	Time(sec)												Sum
	5	10	15	20	25	30	35	40	45	50	55	60	
Water Conductivity in μS	25	26	27	28	29	30	31	32	32	33	34	34	
	34	35	35	35	35	34	34	34	33	33	33	32	
	32	32	32	31	31	31	31	31	31	30	30	30	
	30	29	29	29	29	29	29	28	28	28	28	28	
	28	28	27	27	27	27	27	26	26	26	26	26	
	26	26	26	26	26	26	26	25	25	25			
Total													
Total nr of readings													

Table 5: Summary of flow measurements

Particulars	Set 1	Set 2	Set 3
Number of readings (nr)		91	106
Baseline conductivity(μ_{baseline})		24	24
Sum of readings ($\Sigma\mu$)		3433	3997
Time Intervals (dt) in sec			
Salt constant in (k) in $\mu\text{S}/(\text{mg}/\text{liter})$.			
Determine Effective Area (A) in m^2			
Determine Discharge (Q) in l/s			
Average Discharge			

