3-1

**University of Asia Pacific**
**Department of Civil Engineering**
**Final Examination, Fall 2019**
**Program: B. Sc in Civil Engineering**

Course title: Principles of Accounting    Course Code: ACN 301    Credit: 2.00
Time: 2 hours    Full marks: 50

**Answer all the questions given**

**Question: 1**

**a.** Match the correct term (from the box) with the definition given below. You don't need to rewrite the statements, just maintain the sequence.

| Accrued revenue, prepaid expenses, accrued expenses, unearned revenue |
|---|

- **i.** Cash received before services are performed.
- **ii.** Expenses paid in cash before they are used or consumed.
- **iii.** Revenues for services performed but not yet received in cash or recorded.
- **iv.** Expenses incurred but not yet paid in cash or recorded. 4

**b.** Terry Thomas opens the Green Thumb Lawn Care Company on April 1. At April 30, the trial balance shows the following balances for selected accounts.

| | |
|---|---|
| Prepaid Insurance | $ 3,600 |
| Equipment | 28,000 |
| Notes Payable | 20,000 |
| Unearned Revenue | 4,200 |
| Service Revenue | 1,800 |

Analysis reveals the following additional data.

- **i.** Prepaid insurance is the cost of a 2-year insurance policy, effective April 1.
- **ii.** Depreciation on the equipment is $500 per month.
- **iii.** The note payable is dated April 1. It is a 6-month, 12% note.
- **iv.** Seven customers paid for the company's 6 months' lawn service package of $600 beginning in April. The company performed services for these customers in April.
- **v.** Lawn services provided other customers but not recorded at April 30 totaled $1,500.

**Instructions**
Prepare the adjusting entries for the month of April. Show computations. 10

**Question: 2**

**a.** Staci Valek began dabbling in pottery several years ago as a hobby. Her work is quite creative, and it has been so popular with friends and others that she has decided to quit her job with an aerospace company and manufacture pottery full time. Staci will rent a small building near her home to use as a place for manufacturing the pottery. **(i)** The rent will be $500 per month. She estimates that the (ii)cost of clay and glaze will be $2 for each finished piece of pottery. She will hire workers [Q produce the pottery at a **(iii)** labor rate of $8 per pot]. To sell her pots, Staci feels that she must advertise heavily in the local area. An advertising agency states that it will handle all advertising for a (iv) fee of $600 per month. Staci's brother will sell the pots; he will be paid a (v) commission of $4 for each pot sold. Equipment needed to manufacture the pots will be **(vi)** rented at a cost of $300 per month.

A small room has been located in a tourist area that Staci will use as a sales office. **(vii)** The rent will be \$250 per month. A phone installed in the room for taking orders will **(viii)** cost \$40 per month. In addition, a recording device will be attached to the phone for taking after-hours messages. **(ix)** Staci could keep the money into bank and earn a handsome interest rate instead.

**Requirement:**

Find the identified costs from the business operation of Staci Valek (i-ix) and classify them in the following format. Place an **X** in the appropriate columns to show the proper classification of each cost.

| Name of the cost | Variable cost | Fixed cost | Direct Material cost | Direct Labor cost | Manufacturing overhead | Selling & Administrative cost | Opportunity cost |
|---|---|---|---|---|---|---|---|

**9**

### Question: 3

The Hartford Symphony Guild is planning its annual dinner-dance. The dinner-dance committee has assembled the following expected costs for the event:

| | | |
|---|---|---|
| Dinner (per person) | \$18 | Variable cost |
| Favors and program (per person) | \$2 | Variable cost |
| Band | \$2,800 | Fixed cost |
| Rental of ballroom | \$900 | Fixed cost |
| Professional entertainment during intermission | \$1,000 | Fixed cost |
| Tickets and advertising | \$1,300 | Fixed cost |

The committee members would like to charge \$35 per person for the evening's activities.

**Requirements:**

- **i.** Compute the break-even point for the dinner-dance (in terms of the number of persons who must attend). **2**
- **ii.** Assume that last year only 300 persons attended the dinner-dance. If the same number attends this year, what price per ticket must be charged in order to break even? **3**
- **iii.** Refer to the original data (\$35 ticket price per person), Prepare a CVP graph for the dinner dance from zero tickets up to 600 tickets sold. **5**

### Question: 4

**a.** Consider the following cash flows of two mutually exclusive projects for Tokyo Rubber Company. Assume the discount rate for Tokyo Rubber Company is 10 percent.

| Year | Dry Prepreg | Solvent Prepreg |
|---|---|---|
| 0 | -\$ 14,00,000 | -\$6,00,000 |
| 1 | 9,00,000 | 3,00,000 |
| 2 | 8,00,000 | 5,00,000 |
| 3 | 7,00,000 | 4,00,000 |

**Requirements:**

- **i.** Based on the payback period, which project should be taken? **2**
- **ii.** Based on NPV, which project should be taken? **8**
- **iii.** Based on Profitability Index, which project should be taken? **2**

**b.** Write down the decision criteria for choosing projects in terms of NPV, payback period, and profitability index. **5**

Best of Luck ☺

# University of Asia Pacific
## Department of Civil Engineering
## Final Examination Fall 2019
## Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering I — Course Code: CE 331
Time: 3.00 Hours — Credit Hour: 3.00 — Full Marks: 150

***Answer all the questions. Assume any missing data.***

1. (a) What are the challenges of selecting groundwater as a water supply source in Bangladesh? A tubewell is 460 mm in diameter. The unconfined aquifer is of 18 m depth. After drawdown, depth of water is 12 m in the well. Calculate the discharge of the tubewell if permeability of soil is 24.5 m/d and radius of circle of influence is 275 m. [7.5+7.5]

**OR**

A family of 8 persons in an arsenic and saline affected area of Bangladesh have planned to install rain water harvesting system (RWHS) as an alternative water supply option. Calculate the minimum capacity of storage tank required for the purpose with the following data: water demand = 10 lpcd of rainwater; yearly rainfall intensity = 2.5 m and the rainfall distribution is such that at least 35% of the rainwater must be stored for uninterrupted water supply throughout the year. [7.5+7.5]
What challenges this family may face for choosing this alternative water supply option?

(b) What is per capita water demand? Explain the factors affecting the water demand of an area. [5+10]

2. (a) Distinguish between plain and chemical sedimentation. Derive the equation of free settling velocity for a particle in a sedimentation tank. [5+10]

(b) Explain the purposes of using pump in WSS. Design the transmission main and the pumping unit with 80% efficiency from the following data: [5+10]
Water supply rate: 50 gpcd
Design population: 90000
R. L. at pump house: 105 ft
R. L. at treatment plant: 195 ft
Velocity of water through pipe: 10 fps
Pumping time: 8 hr/day
Total length of pipe: 3500 ft
Frictional factor of pipe: 0.01.

3. (a) Explain with chemical reactions: [15]
Co-precipitation and adsorption process of an arsenic removal plant (figure required).

**OR**

Lime and soda ash process for water softening (figure required).

(b) Compare between slow sand filter (SSF) and rapid sand filter (RSF) in terms of: i) filter bed ii) cost iii) maintenance. [15]

4. (a) Explain the term "Water Safety Plan (WSP)" including its components. What are the risks you need to consider during preparation of a WSP for shallow hand pump tubewell technology? [7.5+7.5]

(b) Explain with neat sketches the different methods of water transmission and distribution. In your opinion, among these methods which one is suitable for Dhaka city and why? [10+5]

5. (a) Write short notes on: i) Water demand management ii) Metering of water. [7.5+7.5]

(b) Using a flow diagram, show the locations of water losses in a piped water supply system. Calculate the corrected flows in the various pipes of the distribution network as shown in following Fig. 1 (use Hardy Cross method). The diameters and lengths of the pipes used are given against each pipe. One trial is required. [5+10]

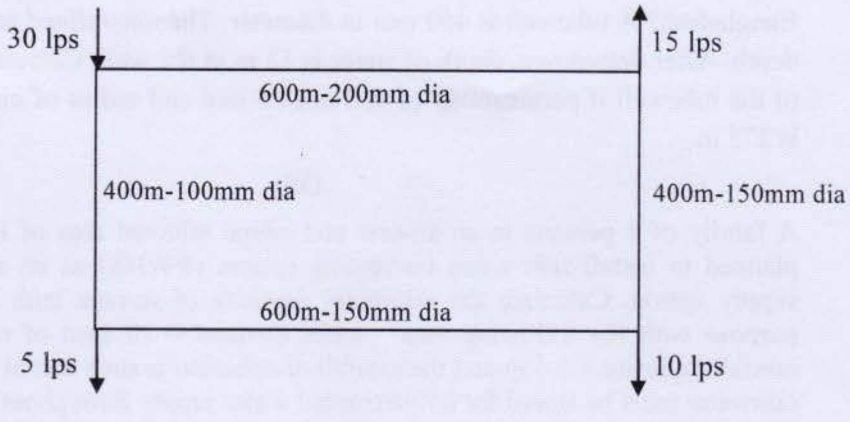



Fig. 1.

**University of Asia Pacific**
**Department of Civil Engineering**
**Final Examination Fall 2019**
**Program: B.Sc. Engineering (Civil)**

Course Title: Geotechnical Engineering I — Course Code: CE 341

Time: 3 hours — Credit Hours: 3.00 — Full Marks: 150

**Answer the following questions.**

1. Apply Rankine's theory of lateral earth pressure for the following:
   - (a) Compute the magnitude of lateral force (per unit length of the wall) acting on the earth retaining structure in active condition (Fig. 1). Consider up to the dredge line. 12
   - (b) Calculate the change in the lateral force in active case, if soils of both the layers have 10 kPa of cohesion. 4
   - (c) Calculate the depth of tensile crack for the condition stated in Q 1(b). 6

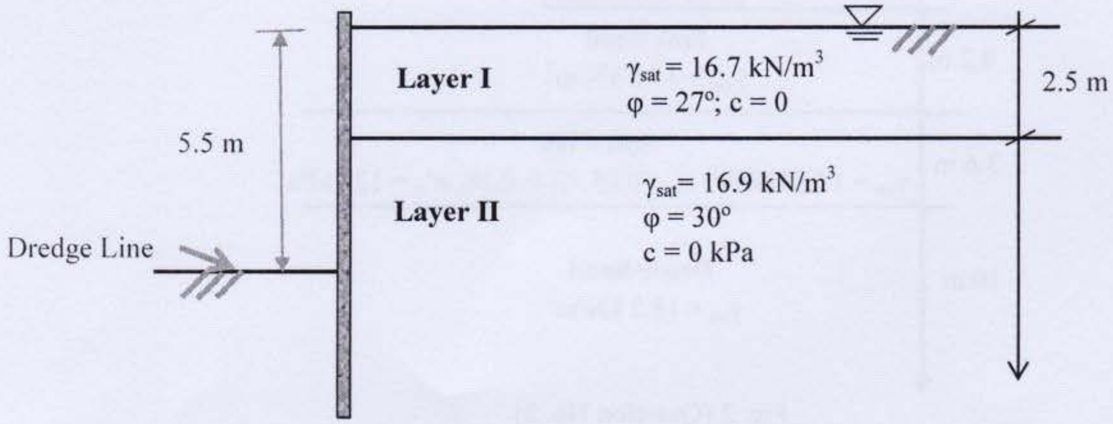



Fig.1 (Question No. 1)

2. (a) A square footing (2 m x 2 m), in the soil profile (Fig. 2), transmits 1120 kN column load to soil below the footing. 8
   Determine the increase in vertical stress (Δσ) at the mid depth of the clay layer below the centre of the footing using equivalent point load method.

   Boussinesq equation for vertical stress due to point load: $\sigma_z = \frac{3Q}{2\pi} \cdot \frac{z^3}{(r^2+z^2)^{5/2}}$

   (b) Calculate the over-consolidation ratios (OCR) for a soil element at the mid- depth of the clay layer for both the conditions: before increase in stress and after increase in stress (as calculated in Q 2a). 6
   Given that pre-consolidation pressure of the clay layer = 125 kPa.

(c) Estimate the primary consolidation settlement of the clay layer (Fig.2). Apply 2V:1H stress distribution for calculating increase in stress. 16

(d) Calculate the time for the clay layer (3.6 m thick) to settle 11 mm due to applied stress. Given that coefficient of consolidation, $c_v = 0.24\ mm^2/s$, and under the given stress the total estimated primary consolidation settlement is 19 mm. 3

$$T_v = \frac{\pi}{4}.\left(\frac{U}{100}\right)^2$$

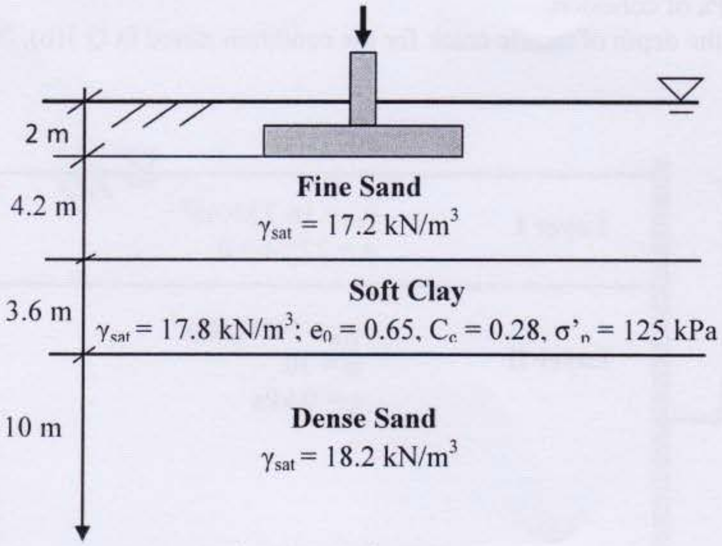



Fig. 2 (Question No. 2)

3. The shear force versus displacement curves obtained from direct shear tests are given in Fig. 3. The dimension of the shear box is 60 mm x 60 mm. 15

Determine the shear strength parameters both for peak and ultimate shear strengths of the soil. Use graph paper for plotting Mohr-Coulomb failure envelopes.

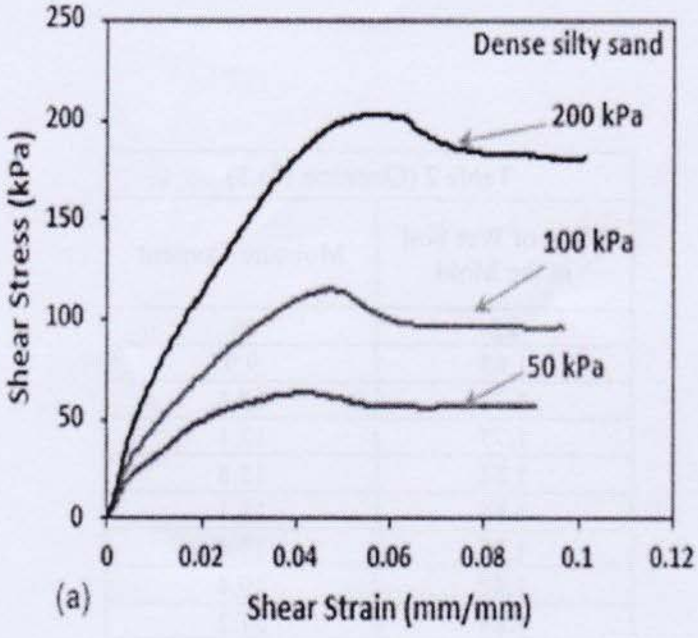



Fig. 3 (Question No. 3)

4. The results of three CU triaxial tests were given in Table 1.

(a) Determine shear strength parameters for effective stress analysis. 15

(b) Determine the orientation of the failure plane. 5

| Table 1 (Question No. 4) | | | |
|---|---|---|---|
| **Specimen ID** | **A** | **B** | **C** |
| Total Cell Pressure (kPa) | 300 | 500 | 600 |
| Initial Pore Pressure (kPa) | 203 | 315 | 205 |
| Deviator stress at failure (kPa) | 73 | 91 | 131 |
| Failure strain (%) | 5.1 | 7.8 | 12.0 |

5. The results of standard Proctor test is given (Table 2). Volume of mold = 944 $cm^3$.

(a) Determine the Optimum Moisture Content and Maximum Dry Unit Weight. 12

(b) Plot zero air void line and 80% saturation line. 7
Specific gravity of soil is 2.7.

| Table 2 (Question No.5) | |
|---|---|
| Mass of Wet Soil in the Mold | Moisture Content |
| kg | % |
| 1.68 | 9.9 |
| 1.71 | 10.6 |
| 1.77 | 12.1 |
| 1.83 | 13.8 |
| 1.86 | 15.1 |
| 1.88 | 17.4 |
| 1.87 | 19.4 |
| 1.85 | 21.2 |

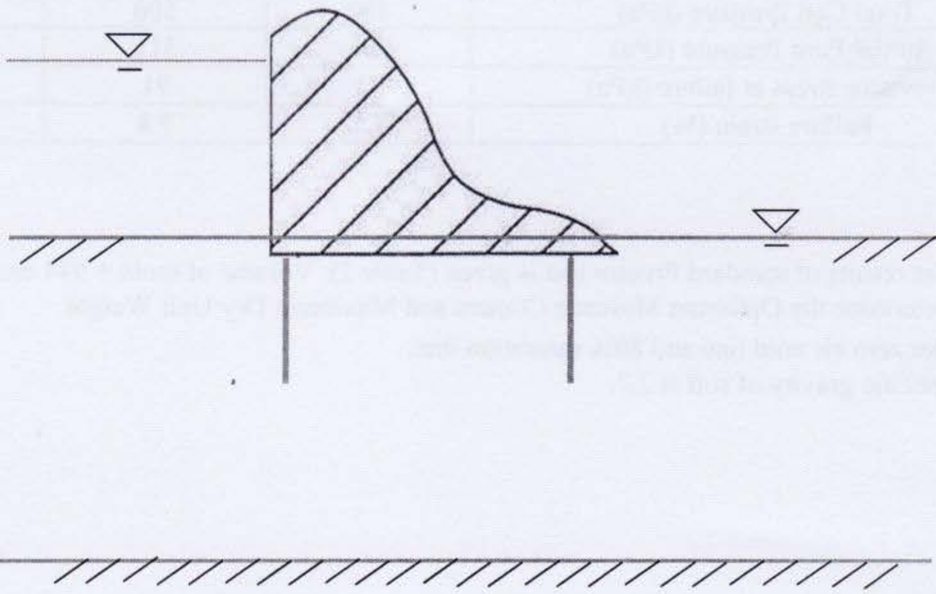
6. (a) Sketch a flow-net for a concrete dam with two cutoff walls, as shown in Fig. 4. 5
Determine the number of flow channels. 3

(b) A flownet for a dam with one cutoff wall is given in Fig. 5.

(i) Estimate the seepage flow rate under the dam. 6

(ii) Calculate heads at Point 'A' and Point 'B'. 4

(iii) Apply the flownet technique to plot the uplift pressure diagram under the base of the dam. 8



**Impervious Layer**

Fig. 4 (Question No. 6a)

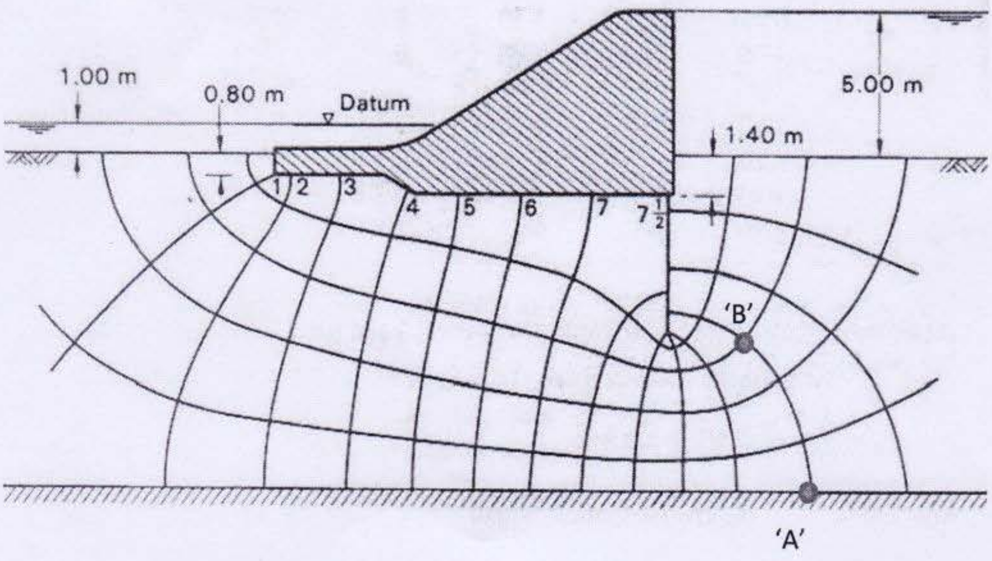



Fig. 5 (Question No. 6b)

7. (a) Classify the following soil according to Unified Soil Classification System: 9
Given Data:
% of Sand = 14.5, % of Silt = 63.7, % of Clay = 21.8
Liquid Limit = 47.2%
Plastic Limit = 19.2%

(b) Determine the coefficients required to apply USCS for the sieve analysis results given in Fig. 6. 6

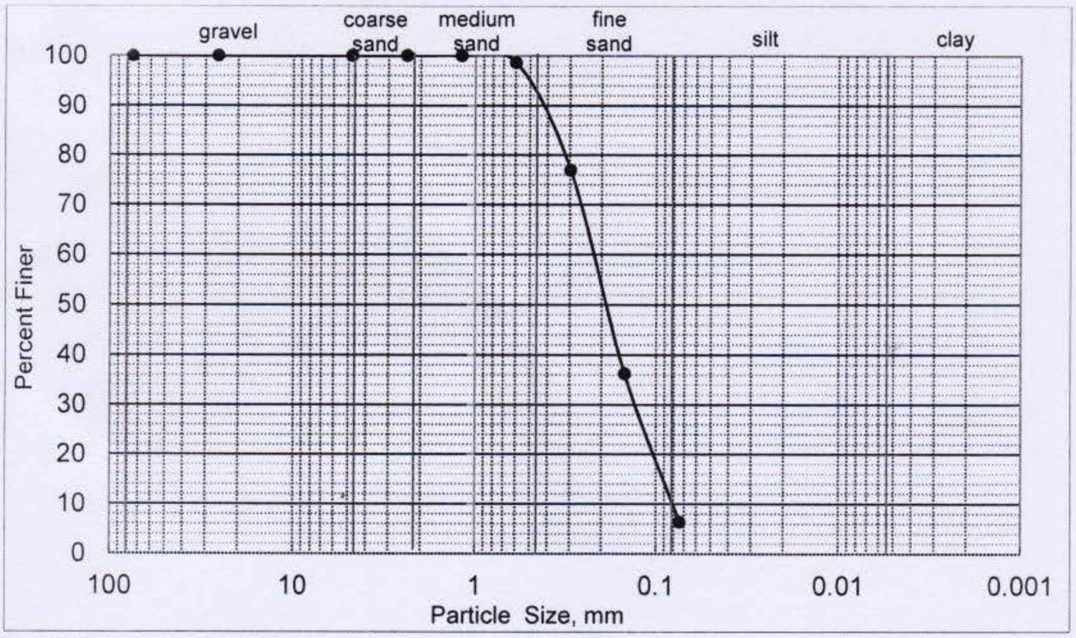



Fig. 6 (Question No. 7)

## University of Asia Pacific
## Department of Civil Engineering
## Final Examination Fall 2019
## Program: B. Sc. Engineering (Civil)

Course Code: CE 315 — Time: 3 Hours
Course Title: Design of Concrete Structures-I — Full Marks: 150

*Answer **all** the questions. (**Assume** reasonable value for any **missing data**)*
[Use $f'_c$ = 4000 psi, $f_y$ = 60,000 psi, $\beta_1 = 0.85$ for all questions]

1. (a) Compare plain concrete with reinforced concrete in terms of structural safety, strength and economy. (9)
(b)State the fundamental assumptions to design concrete structures using USD and WSD methods. (9)

2. (a) What is Whitney's stress block? Explain why it is used in USD method. (4.5+4.5=9)
(b) What is an under-reinforced beam? Explain why in actual practice, the upper limit of reinforcement ratio ($\rho$) should be below the balanced reinforcement ratio ($\rho_b$). (4.5+4.5=9)

3. Explain "Development length" and "Bundled bars" with proper sketches. (9)

4. Compute the uniformly distributed load $'W_{LL}'$ that will produce the first tension crack at the section B of the RC rectangular beam shown in **Figure 1**. Consider self-weight of beam to calculate load. (15)

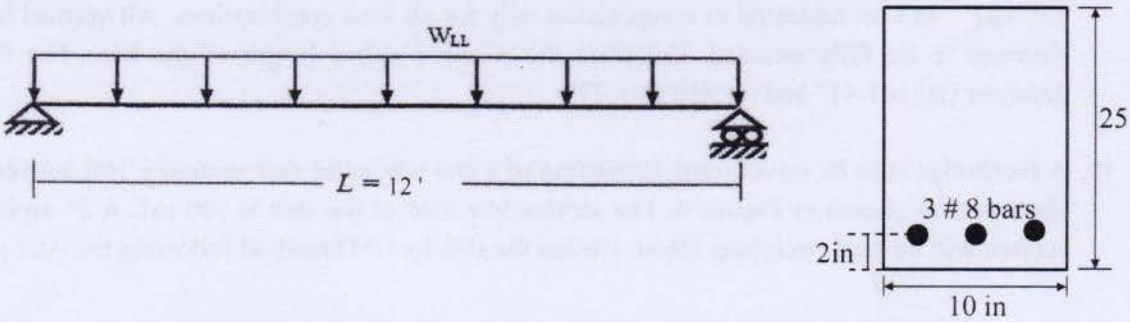



**Figure: 1**

5. Analyze the section of the beam (as shown in **Figure 2**) to determine the design moment capacity. Given, $E_s = 29\times10^6$psi and use $\epsilon_y = f_y/E_s$ (20)

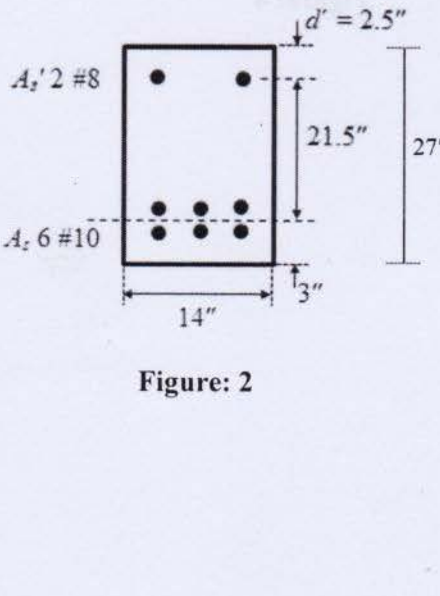



**Figure: 2**

6. Design a simply supported rectangular beam (dimensions of the beam and steel area) of 15feet span for moment using USD method. The beam has to carry a uniformly distributed computed dead load (including its self-weight) of 2.50 k/ft and a service live load of 1.5 k/ft. Given, $\phi$= 0.9 (20)

7. A floor system, shown in **Figure 3** consists of a 3″ concrete slab of 47″ on centers and supported by continuous T beams of 24 ft span. (15)
   Dimensions of the beam are $b_w$ = 11″ and d=20″ as shown in **Figure 3**. Calculate the required tensile steel area at mid-span to resist a factored moment of 700 kip-ft?

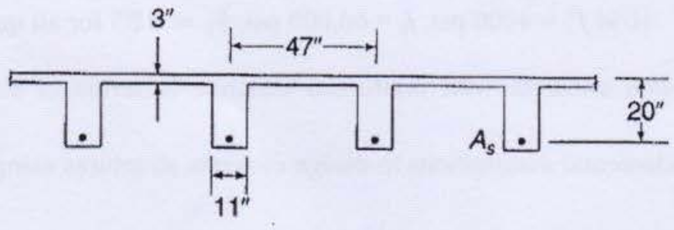



**Figure: 3**

8. A rectangular beam is to be designed to carry a shear force ($V_u$) of 27 kips. No web reinforcement is to be used. Obtain the minimum cross section of the beam if controlled by shear? (10)

9. Four #11 bars of column, below from a floor are to be lap spliced with four #10 bars from above, and the splice is to be made just above a construction joint at floor level. The column cross section is 12″ ×21″, will be subjected to compression only for all load combinations. All vertical bars may be assumed to be fully stressed. Calculate the required splice length of the bars. For #11 the bar diameter ($d_b$) is 1.41″ and for #10 its 1.27″. (10)

10. A footbridge is to be constructed, consisting of a one way solid slab spanning 16ft between masonry abutments as shown in **Figure 4**. The service live load of the slab is 100 psf. A 2″ asphalt wearing surface will be used, weighing 20psf. Design the slab by USD method following the ACI provisions. (15)

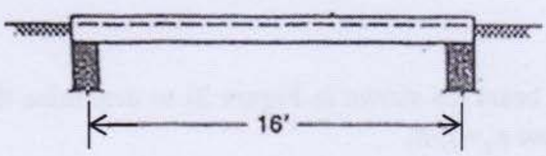



**Figure: 4**

## ***Formulae***

*$f_c = My/I$ , $f_s = n(My/I)$

*$M = \left[\frac{f_c(kj)}{2}\right] bd^2$

*$M_u = \emptyset R bd^2$

*$M = A_s f_s jd$

* $a = \frac{A_s f_y}{0.85 f_c' b}$

* $b\left[\frac{(kd)^2}{2}\right] - nAs(d - kd) = 0$

* $j = 1 - \frac{k}{3}$

* $a = \frac{A_s f_y}{0.85 f_c' b}$

*$A_{sf} = 0.85 f_c'(b - b_w)\frac{h_f}{f_y}$

* $M_{n1} = A_{sf} f_y (d - \frac{h_f}{2})$

* $M_{n2} = (A_s - A_{sf}) f_y \left(d - \frac{a}{2}\right)$

* $a = \frac{(A_s - A_{sf}) f_y}{0.85 f_c' b_w}$

*$c = a/\beta_1$

$M_n = M_{n1} + M_{n2}$

*$M_u = \emptyset M_n$

*$V_c = 2\lambda\sqrt{f_c'} b_w d$

* $l_d/d_b = (3/40)\,(f_y/\sqrt{f_c'})\,(\alpha\beta\gamma\lambda)/\{(c + K_{tr})/d_b\}$

*$\rho_{0.005} = 0.85\beta_1 \frac{f_c'}{f_y}\frac{\epsilon_u}{\epsilon_u + 0.005}$

$$\rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y}\frac{\epsilon_u}{\epsilon_u + 0.004}$$

$$M_{n1} = A_s' f_y (d - d')$$

$$M_{n2} = (A' - A'_s) f_y \left(d - \frac{a}{2}\right) \qquad a = \frac{(A_s - A'_s) f_y}{0.85 f_c' b}$$

$$\bar{\rho}_b = \rho_b + \rho'$$

$$\frac{c}{d'} = \frac{\epsilon_u}{\epsilon_u - \epsilon_Y}$$

$$\rho_{cy} = 0.85\beta_1 \frac{f_c'}{f_y}\frac{d'}{d}\frac{\epsilon_u}{\epsilon_u - \epsilon_Y} + \rho'$$

$$f_s' = \epsilon_u E_s \frac{c - d'}{c}$$

$$k = \frac{n}{n + r}$$

$$j = 1 - \frac{k}{3}$$

$$l_{dc} = \frac{0.02 f_y}{\lambda\sqrt{f_c'}}$$

$$l_{dc} = 0.0003 f_y d$$

$$M = \left[\frac{f_c(kj)}{2}\right] bd^2$$

* $M_u = \emptyset \rho f_y b d^2 \left(1 - 0.59\frac{\rho f_y}{f_c'}\right)$

* $A_s = M_u/[\emptyset f_y\{d-(a/2)\}]$

*Symmetrical T beams
$b < 16h_f + b_w$
$b <$ Span/4
$b <$ c/c beam spacing

*Beam having slab on one side
$b <$ span/12+$b_w$
$b < 6h_f + b_w$
$b <$ Half the clear span $+b_w$

*Isolated T beam
$h_f > b_w/2$
$b < 4b_w$

**Minimum thickness *h* of nonprestressed one-way slabs**

| | |
|---|---|
| Simply supported | $l/20$ |
| One end continuous | $l/24$ |
| Both ends continuous | $l/28$ |
| Cantilever | $l/10$ |

**Minimum ratios of temperature and shrinkage reinforcement in slabs based on gross concrete area**

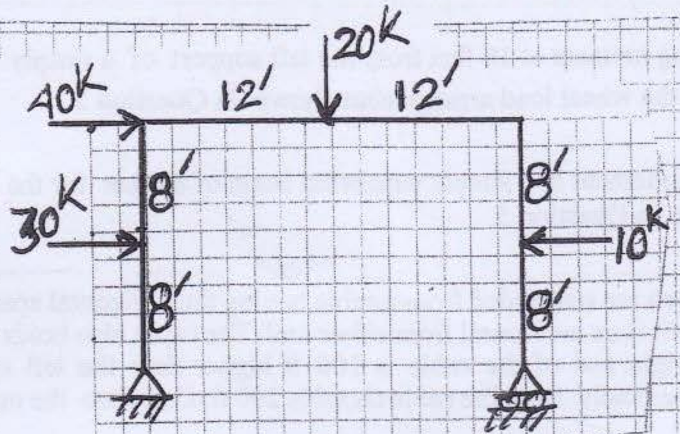
| | |
|---|---|
| Slabs where Grade 40 or 50 deformed bars are used | 0.0020 |
| Slabs where Grade 60 deformed bars or welded wire fabric (smooth or deformed) is used | 0.0018 |
| Slabs where reinforcement with yield strength exceeding 60,000 psi measured at yield strain of 0.35 percent is used | $\frac{0.0018 \times 60{,}000}{f_y}$ |

**University of Asia Pacific**
**Department of Civil Engineering**
**Final Examination Fall 2019**
**Program: B. Sc. Engineering (Civil)**

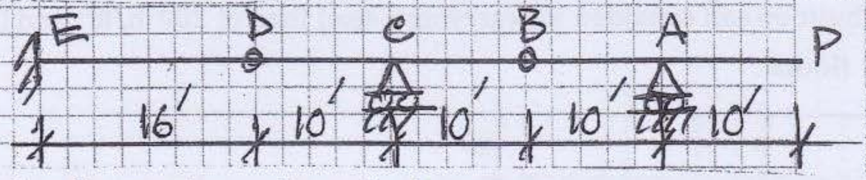
**Course: Structural Engineering I**
**Time: 3.00 Hours**
Credit Hour : 3.0
**Course Code: CE 311**
**Full Marks: ........ 100**

***Answer all the Questions***
***Assume any missing data reasonably.***

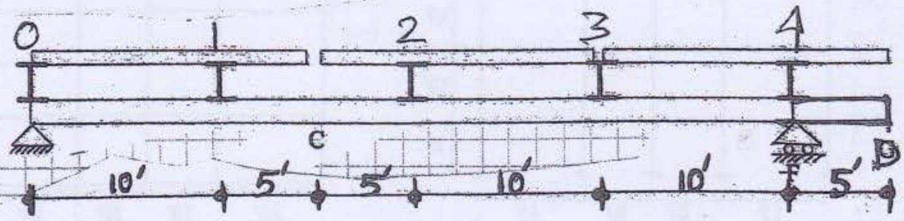
1. Draw the shear force and bending moment diagram of the structure shown in the figure below. (10)



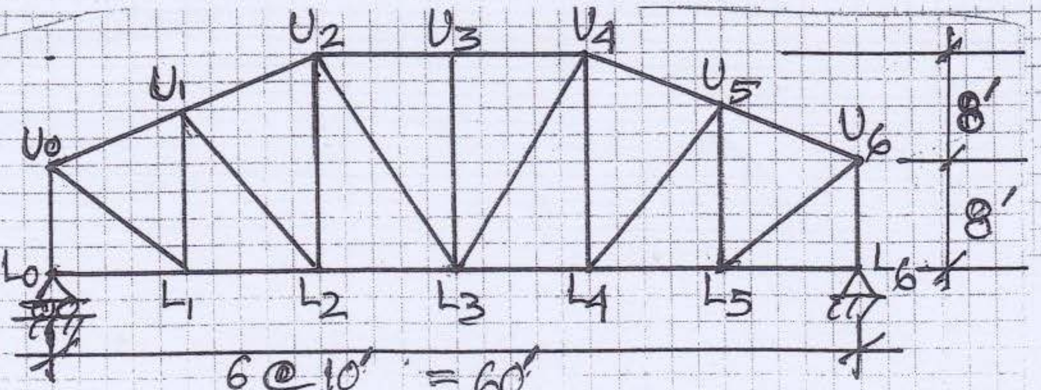

2. For the beam shown in the figure below, carrying a dead load of 3 kip/ft and a moving live load of 2 kip/ft, calculate the : (i) Maximum reaction at C, (ii) Maximum moment at E and (iii) Maximum shear at just right of C. (12)



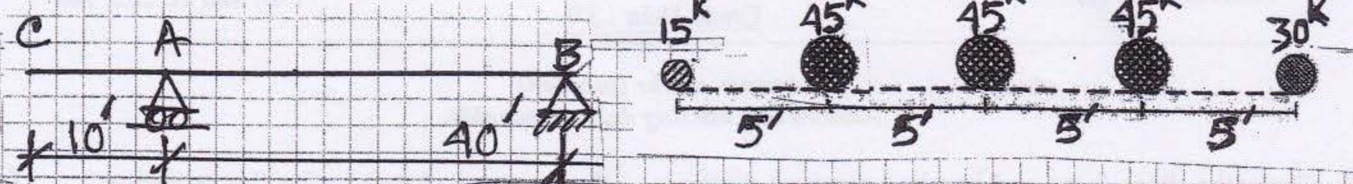

3. The girder supports a floor system as shown in the figure below. Draw influence line for (10)
   (i) Floor beam reaction at panel point 3,
   (ii) Bending moment at panel point 2,
   (iii) Shear in panel 1-2.




4. For the truss shown below, draw influence lines of bar U2L3 and U1U2. Note that each bottom chord joint consists of a cross girder and load moves over the simple floor beams placed over the cross girders. Also calculate the maximum axial force in member U2L3 for a uniformly distributed dead load of 8 kip/ft, a moving live load of 4 kip/ft and a moving point live load of 50 kip. (10)



5. Calculate the maximum reaction at support A of the following beam for the wheel load arrangement shown below (12)

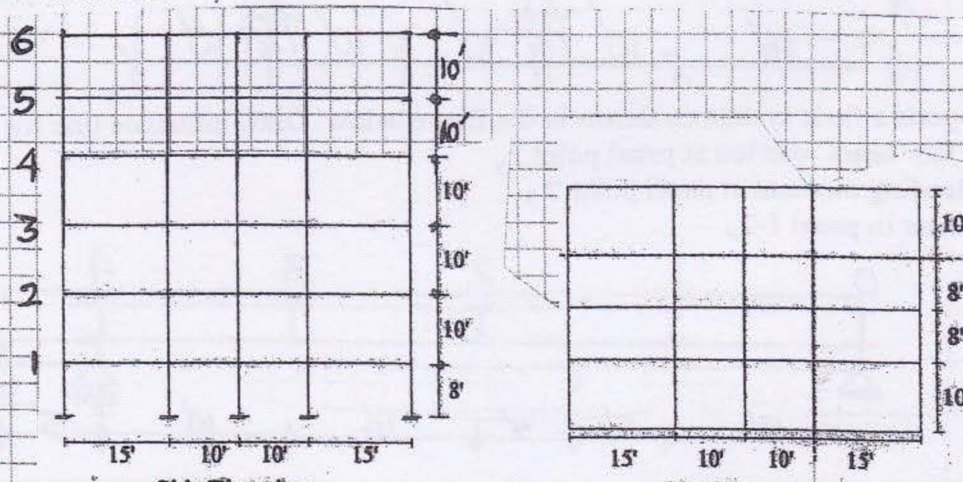



6. Calculate the maximum bending moment at 16 feet from the left support of a simply supported beam of 60 feet for the wheel load arrangement shown in Question 5. (12)

7. Calculate the greatest bending moment in a simply supported beam of 80 feet for the wheel load arrangement shown in Question 5. (10)

8. Three point loads of 120 kip each are suspended from a cable having the horizontal span of 600 ft. Three loads are spaced @ 150 ft on horizontal from either end. The cable also holds UDL of 3 kips/ft on horizontal. The right end of the cable is 100 ft higher than the left end. The maximum distance measured vertically from the cable chord is 200 ft. Calculate the maximum tension in the cable. (12)

9. Calculate the seismic load at story 3 and 4 of the six storied building as shown below. The building is located in Sylhet (Zone 3). Assume the structure to be Special Moment Resisting Frame (SMRF) built on soil condition S2, carrying a dead load of 200 lb/$ft^2$ and live load of 60 lb/$ft^2$ on all floors. (12)




Side Elevation

Plan View

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination Fall 2019
# Program: B. Sc. Engineering (Civil)

| | | |
|---|---|---|
| Course Title: Open Channel Flow | | Course Code: CE 361 |
| Time: 3.00 Hours | Credit Hour: 3.00 | Full Mark: 150 |

**Answer all the questions in both of the sections. (25*6= 150)**
**(Necessary formulae are attached; Assume reasonable data if necessary)**

## SECTION – A

1 (a) Indicate examples and notations (conditional expressions) for the following types of flow: i)Unsteady rapidly varied flow ii) Steady spatially varied flow. (10)

**OR**

Explain the laws on which the governing equations of steady one-dimensional open channel flow are based upon.

(5 + 10)

(b) Explain the velocity distribution in open channel flow.

Consider the following data for the Padma river at the Baruria station in Faridpur on the 2nd July, 1989: $A = 33,500\ m^2$, $Q = 56,200\ m^3/s$ and $B = 3820$ m. Compute the state of flow. Assume the river is wide (Hint: consider rectangular channel, $\nu = 10^{-6}\ m^2/s$).

**OR**

Explain why $\alpha$ and $\beta$ are used in open channel flow.

There is a sharp crested weir in a rectangular channel where the discharge per unit width of the weir is $4.5\ m^2/s$. The upstream and downstream depths in the channel are 2.5 m and 1 m respectively. Estimate the force on the weir plate.
[Hint: Expression of hydrostatic force as $F_1 = 0.5\gamma h_1^2$; $F_2 = 0.5\gamma h_2^2$]

2(a) Relate the "locations of control sections" with the state of flow. Explain control sections with examples and figures. (5+5)

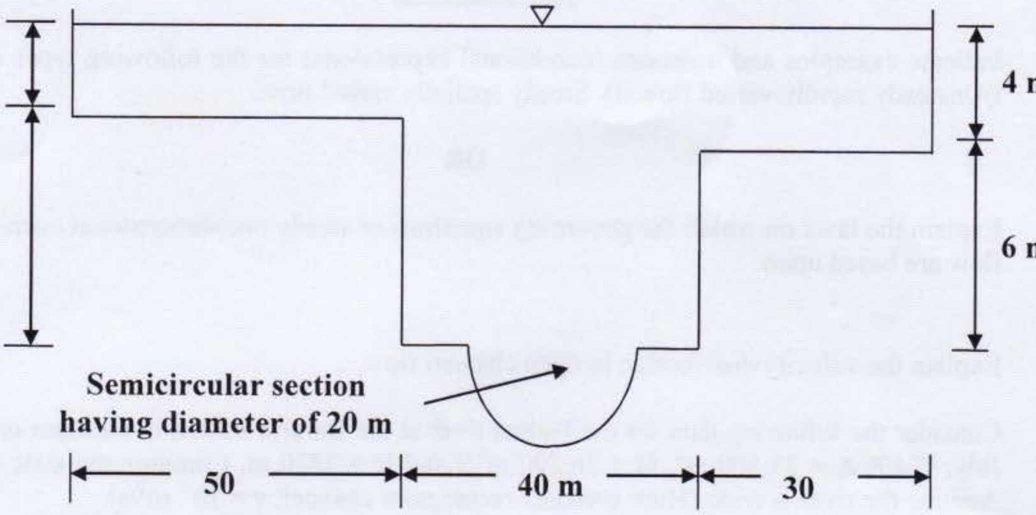
**OR**

Apply energy equation to demonstrate the formula for computation of discharge by slope-area method. Explain the assumptions in analyzing compound cross sections in open channels.

(b) A rectangular channel has a bottom width of 6m. (a) Produce the specific energy curve for a discharge of 15 m3/s and determine the critical depth and the minimum value of the specific energy. (b) Produce the discharge-depth curve for a specific energy of 3 m and determine (15) the critical depth and the maximum value of the discharge.

**OR**

A channel consists of a main section and two side sections as shown in the following figure. Compute the total discharge, the mean velocity of flow and the Manning's n for the entire section when n = 0.025 for the main channel, n = 0.045 for the side channels and $S_o$ = 0.0002. Also compute the numerical values of $\alpha$ and $\beta$ for the entire section assuming that $\alpha$ = $\beta$ = 1.00 for the main channels and the side sections.




3(a) Outline the justifications of ensuring the following features in the design of open channels : (10)
i) Freeboard ii) Lining iii) Non-silting velocity.

**OR**

Describe Alluvial Channels. Explain according to Lacey, when a channel is considered to be in true regime.

(b) A group of Engineers are working on a project to construct a trapezoidal channel carrying $20\ m^3/s$ of discharge. The channel will be built with non-erodible bed that has a slope of 1 in 2500 and n = 0.012. If you are in the group of Engineers, make necessary evaluations to design the channel so that it conveys the maximum discharge. Consider side slope s = 1. (15)
[For best hydraulic trapezoidal section, $A = \sqrt{3}h^2$; $P = 2\sqrt{3}h$ ; $R = h/2$ ; $B = 4\sqrt{3}h/3$ ; $D = 3h/4$]

## SECTION – B

4 (a) Show that the best hydraulic triangular section is one-half of a square. (10)

**OR**

Show that the expression for shear stress ratio is $\boldsymbol{K} = \frac{\tau_s}{\tau_b} = \sqrt{\mathbf{1} - \frac{sin^2\phi}{sin^2\psi}}$

(b) A trapezoidal channel has to be designed in your village as part of the drainage augmentation campaign. The canal is to be laid on a slope of 1 in 1500. The channel has to carry a discharge of 20 $m^3/s$ through a course non-cohesive material having $d_{50}$ = 2.5 cm, $d_{75}$ = 3 cm and n = 0.025. The angle of repose of the perimeter material is 32°. Evaluate the section dimensions of the channel by Lane's method. (15)

5 (a) Illustrate the possible flow profiles in **ANY ONE** of the following serial arrangements of channels or conditions. The flow is from left to right: i) mild – milder- steep; ii) steep-mild-milder; iii) critical-steep-mild. (4)

(b) Following the procedure for deriving qualitative flow profiles, show the procedure, analyze and draw **ANY TWO** from following the profiles: i) M1 ; ii) M2 ; iii) S1 ; iv) S2. (7)

**OR**

Identify the possible flow profiles for **ANY TWO** of the following conditions (mention the slopes, the name of the profiles and mark CDL, NDL etc.) :

i) Different water levels downstream of a mild slope channel;
ii) Increase of surface roughness in steep slope channel;
iii) Change in channel width in a mild slope channel.

(c) You work for a consulting firm which works on water resource projects. The firm has taken up a project on making necessary computations related with resulting flow profile in a wide rectangular channel due to placing of a weir. Consider C = 47 $m^{1/2}/s$ and $S_0$ = 0.0001 and also that the channel carries a discharge of 1.8 $m^2/s$. The weir causes the water level to be raised by 0.50 m above the normal depth. Your assignment is to compute the length of the resulting flow profile between the weir site and the location where the depth is 2.8 m by the Bresse method. (drawing required) (14)

**OR**

A trapezoidal channel exists in your village town. The dimensions of the channel are b = 6 m and s = 2 which is laid on a slope of 0.0025 and carries a discharge of 30 $m^3/s$. A dam has been constructed for flow control. The depth produced by a dam immediately upstream of it is 2.5 m. Compute the resulting flow profile (**show four steps**). Take $\alpha$ = 1.12 and n = 0.025. [use $h_n$ = 1.6 m and $h_c$ = 1.33 m]

6 (a) Give examples of practical applications of hydraulic jump. Classify the types of jumps that occur in sloping channels with figure. (3+7)

(b) Water flows at a velocity of 5.5 m/s and a depth of 1 m in a 6.1 m wide horizontal rectangular channel. Compute the following: (15)

i) the relative height of the jump;
ii) The relative energy loss in the jump;
iii) the downstream depth necessary to form a hydraulic jump;
iv) the length of the jump;
v) the type of jump;
vi) the horsepower dissipation in the jump, and
vii) the efficiency of the jump.

## Given Formulae

| | Trapezoidal channel | Circular Channel |
|---|---|---|
| $\bar{U} = \frac{\int_0^A u\, dA}{A}$ | $A = (b + sh)h$ | $h = \frac{d_o}{2}\left[1 - \cos\frac{\omega}{2}\right]$ |
| $\alpha = \frac{\int_0^A u^3 dA}{\bar{U}^3 A}$ | $P = b + 2h\sqrt{1 + s^2}$ | $\omega = 2\cos^{-1}(1 - \frac{2h}{d_o})$ |
| $\beta = \frac{\int_0^A u^2\, dA}{\bar{U}^2 A}$ | $B = b + 2sh$ | $A = (\omega - \sin\omega)\frac{d_o^2}{8}$ |
| | Triangular channel | |
| | $A = sh^2$ | $B = d_o \sin\frac{\omega}{2}$ |
| | $P = 2h\sqrt{1 + s^2}$ | $P = \frac{\omega d_o}{2}$ |
| | $B = 2sh$ | *Note that ω is in radian* |

$Z_c = \frac{Q}{\sqrt{g/\alpha}}$ ; $Z = A\sqrt{D}$ ; $Fr = U/\sqrt{gD}$ ; $Re = UR/\nu$;

**Uniform flow formulae:**

$U = CR^{1/2}S_f^{1/2}$ ; $U = \sqrt{8g/f}\, R^{1/2}S_f^{1/2}$ ; $U = (1/n)\, R^{2/3}S_f^{1/2}$ $Z = AR^{2/3}$; $Z = AR^{1/2}$

**Governing equation for Gradually Varied Flow:** $\frac{dh}{dx} = \frac{S_o - S_f}{1 - Fr^2}$

For wide channel, $h_c = \sqrt[3]{(\frac{q^2}{g})}$ ; $h_n = \sqrt[3]{\frac{q^2}{C^2 S_o}}$

Rectangular channel: $h_c = \sqrt[3]{\frac{\alpha Q^2}{gb^2}}$ ; $S_c = (\frac{nQ}{AR^{2/3}})^2$

$Fr = U/\sqrt{gD}$; $Q = K\sqrt{S_f}$ ; $K = AR^{2/3}/n$

**Bresse function:**

$\emptyset = \frac{1}{6}\ln\frac{u^2+u+1}{(u-1)^2} - \frac{1}{\sqrt{3}}tan^{-1}\frac{\sqrt{3}}{2u+1}$ Where $u = h/h_n$ ; $L = x_2 - x_1 = \frac{h_n}{S_0}[(u_2 - u_1) - (1 - \frac{h_c^3}{h_n^3})(\Phi_2 - \Phi_1)]$

$$\alpha = \frac{\alpha_1 K_1^3/A_1^2 + \alpha_2 K_2^3/A_2^2 + \alpha_3 K_3^3/A_3^2}{K^3/A^2}$$

$$\beta = \frac{\beta_1 K_1^2/A_1 + \beta_2 K_2^2/A_2 + \beta_3 K_3^2/A_3}{K^2/A}$$

$$n = \left(\frac{P_1 n_1^{3/2} + P_2 n_2^{3/2} + P_3 n_3^{3/2}}{P}\right)^{2/3}$$

**Lane Method:** $\tau_b = 0.40\, d_{75}$

$$K = \frac{\tau_s}{\tau_b} = \sqrt{1 - \frac{sin^2\phi}{sin^2\Psi}}$$

1 lb/ft$^2$ = 47.86 N/m$^2$

**For Hydraulic Jump: (horizontal rectangular channel)**

$$\frac{h_2}{h_1} = \frac{1}{2}\left(\sqrt{1+8F_{r1}^2} - 1\right)$$

$$h_L = \frac{(h_2 - h_1)^3}{4h_1h_2}$$

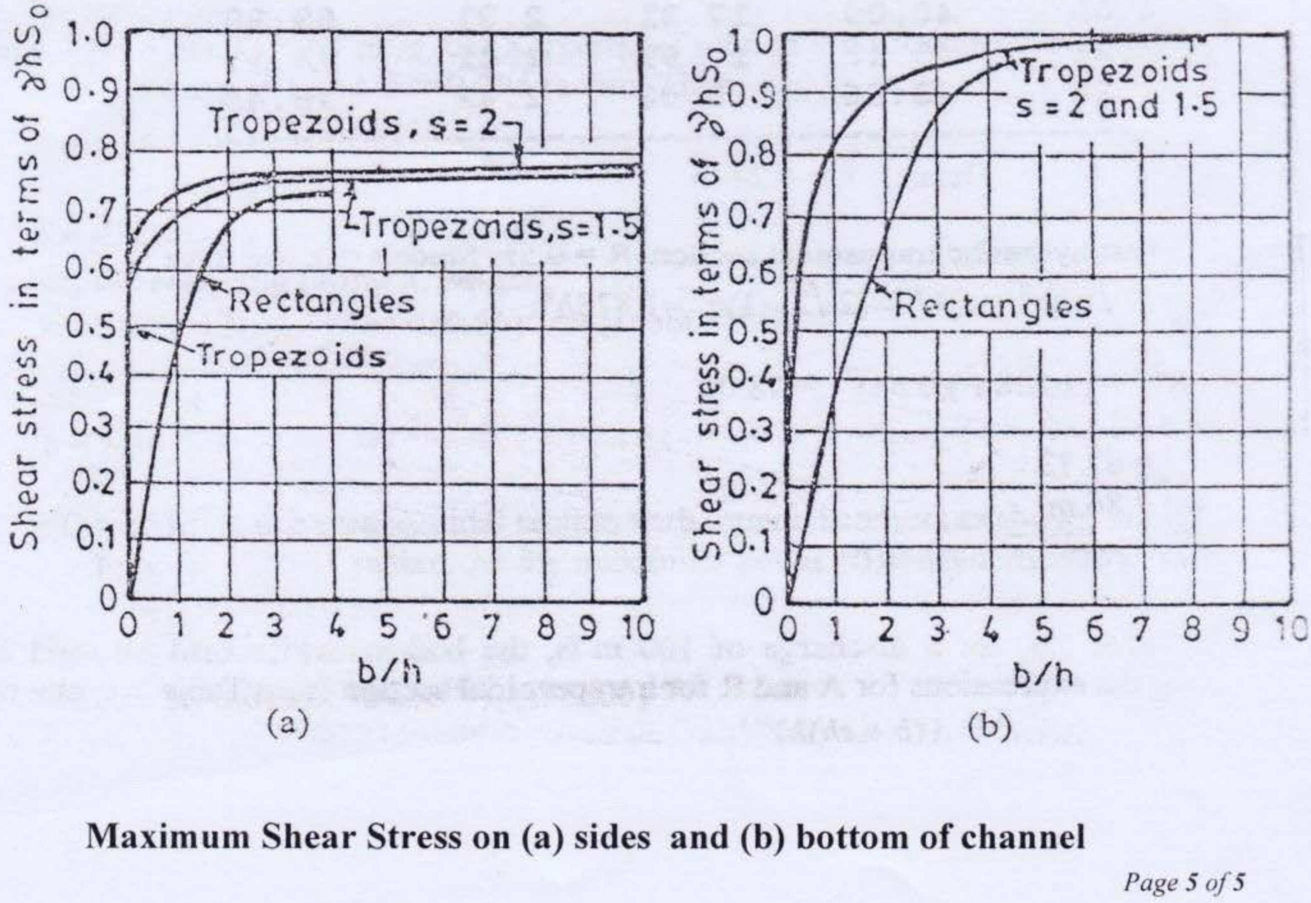
$$\frac{E_2}{E_1} = \frac{(1+8F_{r1}^2)^{3/2} - 4F_{r1}^2 + 1}{8F_{r1}^2(2+F_{r1}^2)}$$

$$\frac{h_j}{E_1} = \frac{\sqrt{1+8F_{r1}^2} - 3}{2 + F_{r1}^2}$$

$$L_j = 9.75h_1(F_{r1} - 1)^{1.01}$$

Power dissipation = $\rho g Q h_L$

1 hp = 745.7 W




**Maximum Shear Stress on (a) sides and (b) bottom of channel**