2.2

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2025
Program: B.Sc. in Civil Engineering
2^{nd} Year 2^{nd} Semester

Course Title: Applied Mathematics for Engineers — Course Code: MTH 203
Time: 3 hours — Credit Hour: 3.00 — Full Marks: 150

Answer all the questions

QUESTION 1 [20 MARKS]

Determine the deformation for an overburden load on a rail track on soil shown in **Fig 1**. The governing equation is $EIu^4+ku = w(x)$.

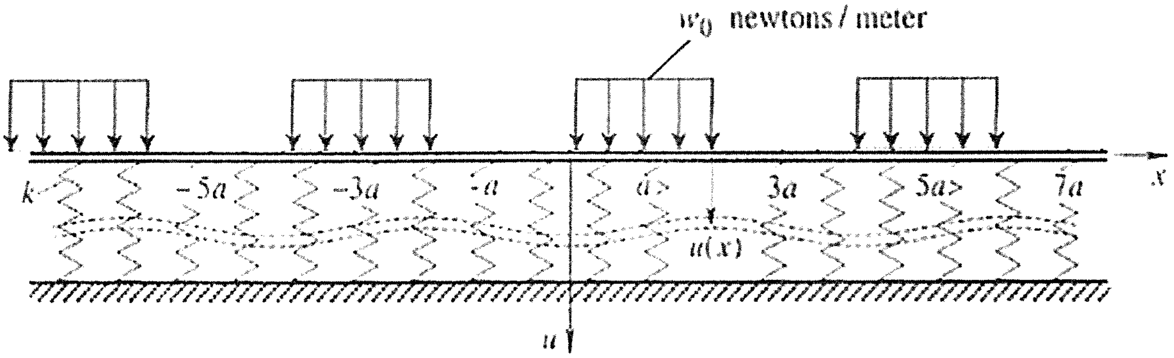


Fig 1

QUESTION 2 [10 MARKS]

Determine the Fourier Integral of a function defined as: F(x) = H(x+1) - H(x-1) and Dirichlet's Discontinuous Factor.

QUESTION 3 [20 MARKS]

Find the followings-

a. $F\{3e^{-|x|} - 4e^{-4|x+5|}\}$ (10)

b. $F^{-1}\{\frac{3}{\omega^2+8\omega+41}\}$ (10)

QUESTION 4 [20 MARKS]

Solve the following differential equations using Laplace transformation.

$$t\frac{d^2x}{dt^2} + \frac{dx}{dt} + 4tx = 0, \quad when\ x(0) = 3\ and\ x'(0) = 0$$

QUESTION 5 [12 MARKS]

An inductor of 3 henrys (H), a resistor of 12 ohms (R), and a capacitor of 0.0256 farads (C) are connected in series with an E.M.F = 255 volts. At t = 0 the charge on the capacitor and current in the circuit are zero. The governing equation is $H\frac{dI}{dt} + RI + \frac{Q}{C} = E$.

Find the charge and current at any time t > 0 using Laplace Transform.

QUESTION 6 [18 MARKS]

Find the followings-

a. $L^{-1}\{4 + s\log\left(\frac{s-1}{s+1}\right)\}$ (10)

b. $L\{\sin 3t \sin 2t\}$ (8)

QUESTION 7 [20 MARKS]

Find the integral surface of the linear partial differential equation, $x(y^2 + z)p - y(x^2 + z)q = (x^2 - y^2)z$, which contains the line $x = -y, z - 1 = 0$.

QUESTION 8 [22 MARKS]

Determine the general solution of the partial differential equations

a. $4r + t - 4s = 8\sin(x + 2y)$ (10)

b. $(D^3 - 2D^2D')z = 3x^2y + xy + \cos(2x + 3y)$ (12)

QUESTION 9 [8 MARKS]

The water surface elevation z in a rural canal is governed by the relation

$$\frac{\partial^2 z}{\partial x^2} = \frac{1}{x}\frac{\partial z}{\partial x}$$

Find the general solution of the PDE to determine the water surface elevation z(x,y).

Table of Fourier Transform

	$f(x)$	$\hat{f}(\omega) = \int_{-\infty}^{\infty} f(x)e^{-i\omega x}\,dx$
1.	$\dfrac{1}{x^2+a^2} \quad (a>0)$	$\dfrac{\pi}{a}e^{-a\vert\omega\vert}$
2.	$H(x)e^{-ax} \quad (\mathrm{Re}\,a>0)$	$\dfrac{1}{a+i\omega}$
3.	$H(-x)e^{ax} \quad (\mathrm{Re}\,a>0)$	$\dfrac{1}{a-i\omega}$
4.	$e^{-a\vert x\vert} \quad (a>0)$	$\dfrac{2a}{\omega^2+a^2}$
5.	e^{-x^2}	$\sqrt{\pi}e^{-\omega^2/4}$
6.	$\dfrac{1}{2a\sqrt{\pi}}e^{-x^2/(2a)^2} \quad (a>0)$	$e^{-a^2\omega^2}$
7.	$\dfrac{1}{\sqrt{\vert x\vert}}$	$\sqrt{\dfrac{2\pi}{\vert\omega\vert}}$
8.	$e^{-a\vert x\vert/\sqrt{2}}\sin\left(\dfrac{a}{\sqrt{2}}\vert x\vert+\dfrac{\pi}{4}\right) \quad (a>0)$	$\dfrac{2a^3}{\omega^4+a^4}$
9.	$H(x+a)-H(x-a)$	$\dfrac{2\sin\omega a}{\omega}$
10.	$\delta(x-a)$	$e^{-i\omega a}$
11.	$f(ax+b) \quad (a>0)$	$\dfrac{1}{a}e^{ib\omega/a}\hat{f}\left(\dfrac{\omega}{a}\right)$
12.	$\dfrac{1}{a}e^{-ibx/a}f\left(\dfrac{x}{a}\right) \quad (a>0,\ b\text{ real})$	$\hat{f}(a\omega+b)$
13.	$f(ax)\cos cx \quad (a>0,\ c\text{ real})$	$\dfrac{1}{2a}\left[\hat{f}\left(\dfrac{\omega-c}{a}\right)+\hat{f}\left(\dfrac{\omega+c}{a}\right)\right]$
14.	$f(ax)\sin cx \quad (a>0,\ c\text{ real})$	$\dfrac{1}{2ai}\left[\hat{f}\left(\dfrac{\omega-c}{a}\right)-\hat{f}\left(\dfrac{\omega+c}{a}\right)\right]$
15.	$f(x+c)+f(x-c) \quad (c\text{ real})$	$2\hat{f}(\omega)\cos\omega c$

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2025
Program: B.Sc. in Civil Engineering
2nd Year 2nd Semester

Course Title: Engineering Economics | Course Code: ECN 201
Time: 3.00 Hours | Credit Hour: 3.00 | Full Marks: 150

Answer all the questions.

QUESTION 1 [25 MARKS]

Analyze the advantages and challenges of LDC graduation for Bangladesh. [25]

QUESTION 2 [25 MARKS]

Explain the difference between perfect competition and monopoly market. [25]

QUESTION 3 [25 MARKS]

a. Describe the law of diminishing marginal utility. [10]

b. Explain the properties of an indifference curve. [15]

QUESTION 4 [25 MARKS]

a. Explain the difference between GDP and GNP. [10]

b. Analyze different methods of calculating GDP. [15]

QUESTION 5 [25 MARKS]

a. $Q = 50-2P$ [15]

$Q = 10+2P$

Calculate equilibrium price and quantity.

b. Explain the effect of change in income on equilibrium. [10]

OR

a. $Q = 100-2P$ [15]

$Q = 20+2P$

Calculate equilibrium price and quantity.

b. Explain the effect of change in input price on equilibrium. [10]

QUESTION 6 [25 MARKS]

Explain the factors which affect demand. [25]

OR

Explain the factors which affect supply. [25]

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2025
Program: B.Sc. in Civil Engineering
2^{nd} Year 2^{nd} Semester

Course Title: Numerical Analysis and Computer Programming (OBE) Course Code: CE 205
Time: 3 hours Credit Hour: 3.00 Full Marks: 100

Answer all the questions

QUESTION 1 [15 MARKS]

In Hydrology lab, an experiment named "Flow through a Venturi Meter" was done to collect Discharge vs Time data provided in the following table. Determine the discharge (Q) when time (t)= 1, 3, 4 sec respectively by forming a **Lagrange Polynomial Equation.**

Time, t (s)	0	2	5	7
Discharge Q (m^3/s)	1.6	3.5	6.8	8

QUESTION 2 [25 MARKS]

In Solid Mechanics lab, an equation, **y=** $x^3+3e^x+\sin x$ was found to determine the reaction force of a cantilever beam by integration. $I = \int_0^6 (x^3 + 3e^x + \sin x)dx$

Prove that by increasing '**n**' from 5 to 10, the obtained integrated value using both the **Trapezoidal Rule and Simpson's Rule** becomes more accurate.

QUESTION 3 [30 MARKS]

Following is a differential equation which is found in Geotechnical lab in UAP while performing an experiment. $\frac{dy}{dx} = (\frac{6x^2+5}{2y})$, **where y(0)=1**

An argument arose while solving this equation using different numerical methods. A student 'A' argues that **Euler method** is best but student 'B' supports **2^{nd} order Runge Kutta method**. In the meantime student 'C' has solved this problem using **Finite Difference Method** and found **y(3)=8.3666**. According to student 'C', this method can give better accuracy.

Now being a mediator, with proper evidence, find out who is right. You can use step size **h=1.**

QUESTION 4 [10 MARKS]

In transportation engineering, these equations used to compute the travel demand (in number of persons) are expressed by

$$-10 = X_1 - 2X_2 - 4X_3$$

$$5 = -2X_1 - X_2 - 3X_3$$

$$8 = X_1 - 2X_2 + X_3$$

Determine the value of X_1, X_2 and X_3 using **Gauss seidel method**. If these equations fail to meet the requirements of using Gauss seidel method, then you can solve the above equations using any other numerical methods from your syllabus.

QUESTION 5 [10 MARKS]

From a test, it was found that the angle (radian) was from 0 to 1.

$y_1 = \sin(5\pi x + 5/3)$, $y_2 = \cos(3\pi x + 1/4)$, $y_3 = \tan(3\pi x + 7/4)$

Now, write a program using **MATLAB** to plot all of 3 curves of (x,y) on the **same paper**. Give proper label, title, legend, grid, colors for all of them. ***You do not need to draw any of them in your answer script.***

QUESTION 6 [10 MARKS]

A rod subjected to an axial load yield the following data up to rupture. Stress-strain values are

Strain	0	0.05	0.10	0.15	0.2	0.25
Stress (k/in^2)	0	25	40	50	65	55

Write a program using **MATLAB** to determine the value of **100 points** of this given Stress-Strain curve and also determine the value of modulus of toughness using **Trapezoidal** method (Write only code)

Relevant Formulae:

For finite difference method: $\frac{dy}{dx} = \frac{Y_{n+1} - Y_n}{h}$

2nd order RK Method: $y_{n+1} = y_n + \frac{1}{2}(k_1 + k_2)$; $k_1 = hf(x_n, y_n)$; $k_2 = hf(x_n + h, y_n + k_1)$

Euler Method: $y_{n+1} = y_n + hf(x_n, y_n)$

Department of Civil Engineering
Final Examination Spring 2025
Program: B. Sc. Engineering (Civil)

Course Title: Mechanics of Solids II　　Credit Hours: 3.0　　Course Code: CE 213
Time: 3 hours　　Full Marks: 100 (= 10 × 10)

PART A (Answer all 5 (Five) Questions)

1. The coordinate of the center of a Mohr's circle is (30, 0) and its radius is 12. If the principal plane is located at an angle $\theta = 30°$ from X axis,

   (i) Calculate the normal stresses (σ_x, σ_y) and shear stress (τ_{xy}) on that plane [all stresses are in ksi].

   (ii) Show these stresses graphically on the Mohr's circle.

2. Calculate the deflection at C and the rotation at A for the beam shown in **Figure 1** [EI = constant].

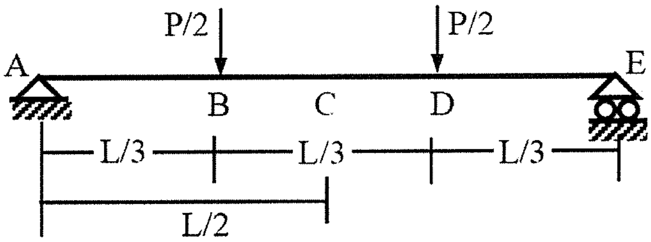


Figure 1

3. The overhanging steel beam ABC carries a concentrated load ***P*** at end C (as shown in **Figure 2**).

   For the portion AB of the beam

   (i) Derive the equation of the elastic curve.

   (ii) Determine the maximum deflection

   (Using the **Direct integration** Method).

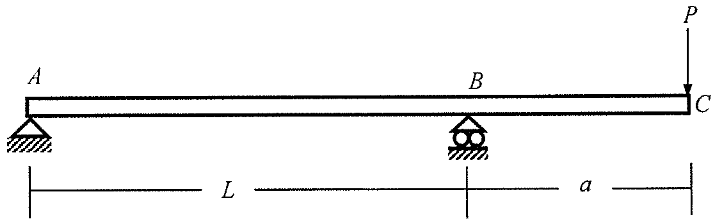


Figure 2

4. The prismatic rods AD and DB are welded together to form the cantilever beam ADB loaded as shown in **Figure 3**.

   Knowing that the flexural rigidity is EI in portion AD of the beam and $2EI$ in portion DB, determine the slope and deflection at end A

   (Using **Moment Area** Method).

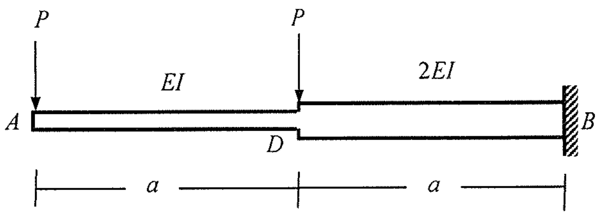


Figure 3

5. **Figure 4** shows the top view of a rectangular weightless block **ABCD**. Assume 10 kN vertically downward force is applied at the point P.

   (i) Determine the **Kern** region of the section **ABCD**.

   (ii) Also plot the stress distribution diagram of section ABCD and locate the line of zero stress.

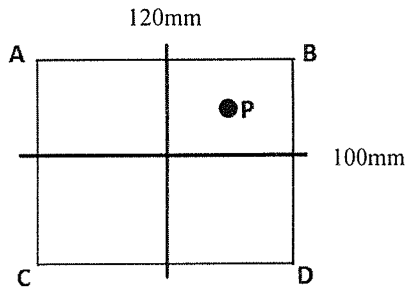


Figure 4

PART B (Answer any 5 (Five) of the following 7 Questions)

[Given: R_0 = Last three digits of Registration #]

6. Calculate the equivalent polar moment of inertia (J_{eq}) for the cross-section shown in **Figure 5** by its centerline dimensions

   [Given: Wall thickness = 0.10′ throughout].

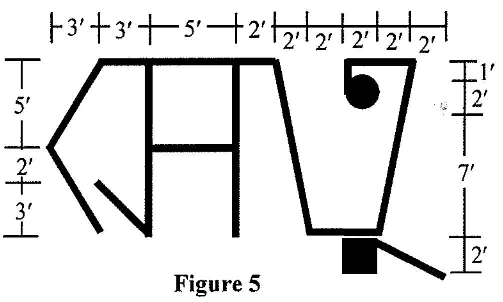


Figure 5

7. Fig. 6(a) shows a part of the *Tora Bridge*, while Fig. 6(b) shows the side view of the portion ACB and the relevant cross-sections at A (throughout AC) and varying linearly up to B.

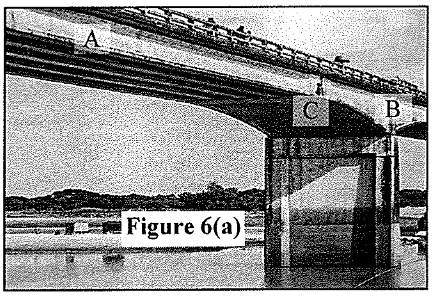
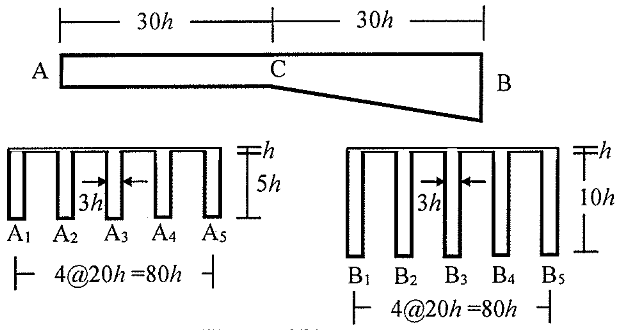


Figure 6(a)



$h = (6 + 0.03R_0)$inch

Figure 6(b)

For an applied constant torque $T_0 = (100 + 0.5R_0)$ k″ over CAB, and shear modulus $G = (1000 + 5R_0)$ ksi

(i) Calculate the relative rotation $\phi_{ABi} = (\phi_B - \phi_A)$ between A and B.

(ii) Calculate $\phi_{ABii} = (\phi_B - \phi_A)$ assuming equivalent polar moment of inertia (J_{eq}) between A and B.

(iii) Determine the value of J_{eq}, if $\phi_{ABii} = \phi_{ABi}$

8. **Figure 7(a)** shows a simply-supported steel girder [span length $L = (100 + 0.1R_0)$ ft] of the *Katakhali Bridge* with a cross-section shown in **Figure 7(b)**.

   Calculate the

   (i) Minimum Buckling Load (P_{cr}) of the steel girder, considering bending about both x- and y-axes

   (ii) - Initial imperfection (v_{i0}) of the steel girder, if transverse deflection $v_{max} = L/50$, when $P = 0.5P_{cr}$

   - Load Eccentricity (e) of the steel girder, if transverse deflection $v_{max} = L/50$, when $P = 0.5P_{cr}$.

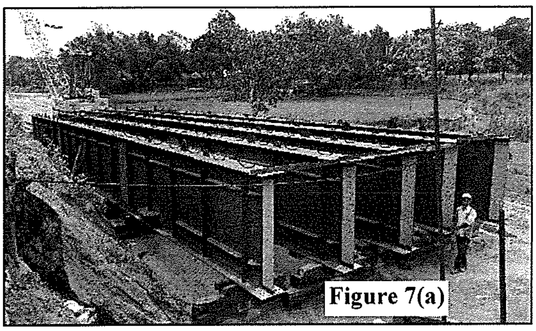


Figure 7(a)

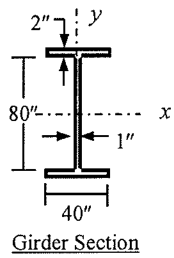


Figure 7(b)

9. The steel girder described in Question 8 [**Figures 7(a)** and **7(b)**] is made of a nonlinear material with stress-strain relationship $\sigma = (300 + 1.5R_0)(\varepsilon)^{0.5}$, where σ is compressive stress (ksi) and ε is strain.

   Calculate the allowable force P for possible buckling

   (i) About x-axis (ii) About y-axis.

10. Use the AISC-ASD method to calculate the allowable force (P_{all}) for the steel girder described in Question 8 [**Figures 7(a)** and **7(b)**] for possible buckling

    (i) About x-axis (ii) About y-axis

    [Given: $f_y = (50 + 0.1R_0)$ ksi, $E = 29000$ ksi].

11. **Figure 8(a)** shows a segment of the *Payra Bridge*, while **Figure 8(b)** shows simplified schematic diagrams of its two piers (*A* and *B*). Given: $H_1 = (15 + 0.05R_0)$ ft, $L_1 = 2H_1$, $E = (2000 + 5R_0)$ ksi, and its columns are of circular cross-section of Diameter $d_0 = H_1/5$.

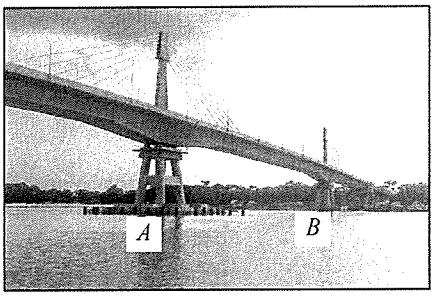


Figure 8(a)

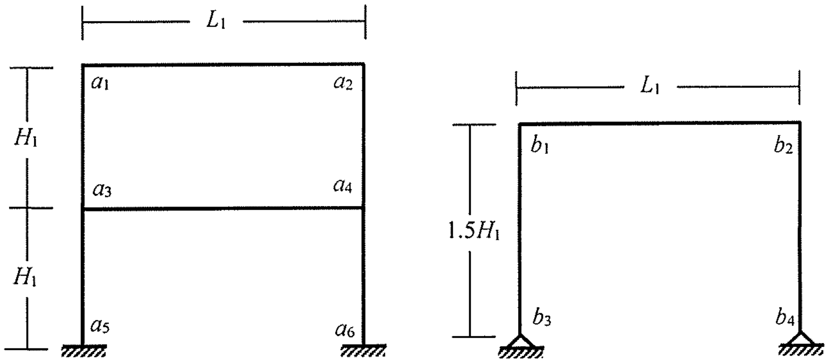


Figure 8(b)

(i) If effective length factor of Column a_3a_5 is $k_{a3a5} = 1.5$, calculate the buckling force of Column a_3a_5 and required EI of the Beam a_3a_4.

(ii) Calculate the effective length factor and buckling force of Column b_1b_3, using the EI value obtained in (i) as also the EI for Beam b_1b_2.

12. **Figure 9(a)** shows the collapse of an overloaded *Bailey Bridge* (with steel truss members) while **Figure 9(b)** shows its simplified schematic diagram.

Given: $W_1 = (10 + 0.01R_0)$ kips, $S_0 = (10 + 0.01R_0)$ ft, $E = 29000$ ksi

(i) Calculate the I_{min} required to avoid buckling of the top-chord member (t_6t_7).

(ii) If member (t_6t_7) is subjected to a 'code-specified' design force P_{all}, obtained by reducing the buckling force used in (i) a safety-factor FS = 1.92, calculate its *Moment Magnification Factor* (*MMF*) using the relevant equation given by

(a) AISC (b) Concentrated midspan force (c) Concentrated end moments (d) UDL.

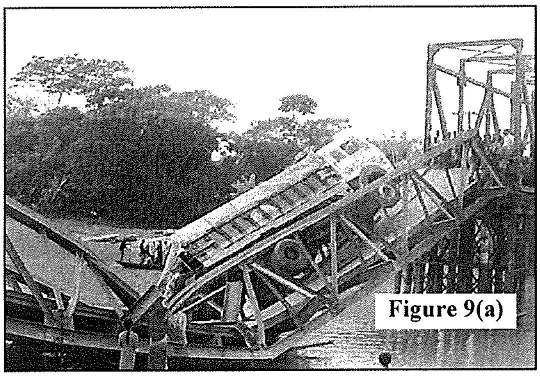


Figure 9(a)

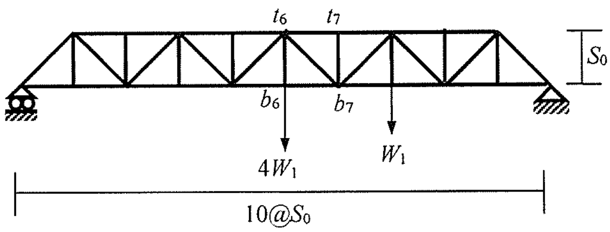


Figure 9(b)

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2025
Program: B.Sc. in Civil Engineering
2nd Year 2nd Semester

Course Title: Fluid Mechanics | Course Code: CE 221

Time: 3 hours | Credit Hour: 03 | Full Marks: 100

<u>There are 3 questions. Please answer them accordingly.</u>

[Assume reasonable data and draw figures if and when needed]

1. **a)** (i) Define the viscous sub-layer. (ii) How are smooth, transitional, and rough pipe flow defined, and how does the friction factor depend on Reynolds number and roughness in each case. Show mathematically. **10**

b) What are the different types of minor head losses in pipe flow? Please briefly define and express each type mathematically. **8**

c) Explain how in a pipe, the shear stress changes linearly from the center and velocity follows a parabolic profile when the flow is laminar? **7**

2. **a)** Derive Bernoulli's theorem for frictionless and incompressible flow. **15**

b) Derive a reasonable equation for the drag force, Fd (exerted on a sphere in a viscous liquid) using Dimensional Analysis. **10**

3. **a)** In Figure A, the pipes 1, 2 and 3 are 300m of 30 cm diameter, 150m of 15 cm diameter and 250m of 25cm diameter, respectively. All of these are commercial steel pipes which flow the water in 15° Celsius. If h = 12m, find the flow rate from A to B using (a) Equivalent Velocity Method and (b) Equivalent Length Method. Please consider relevant minor head losses when you estimate the flow rate. **15**

b) A 2-in-diameter water jet with a velocity of 100 fps impinges on a single vane moving in the same direction at a velocity of 60 fps. If β_2 = 150° and friction losses over the vane are such that $v_2 = 0.9v_1$, compute the force exerted by the water on the vane, and b) loss of power due to friction. The velocity vector diagrams at entrance and exit to the vane are shown in Figure B. **10**

(c) Find out the most reasonable flow distribution within the pipe network given in Figure C. Assume convenient n values for simple analysis. **10**

(d) A pipeline with a pump leads to a nozzle as shown in Figure D. Find the flow rate when the pump develops a head of 24 m, and the pressure head at the suction side of the pump. The head loss in the 15-cm diameter pipe is $H_{L1} = (5V_1^2) / (2g)$, while the head loss in the 10-cm diameter pipe is $H_{L2} = (12V_2^2) / (2g)$. Draw the energy line and the HGL. **15**

Figure A

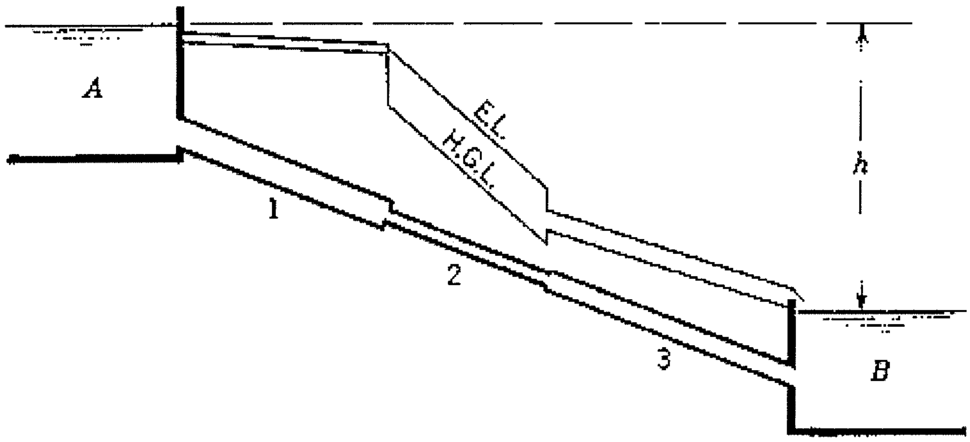


Figure B

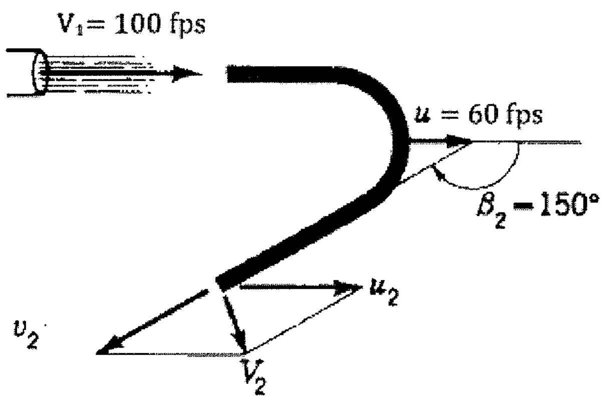


Figure C

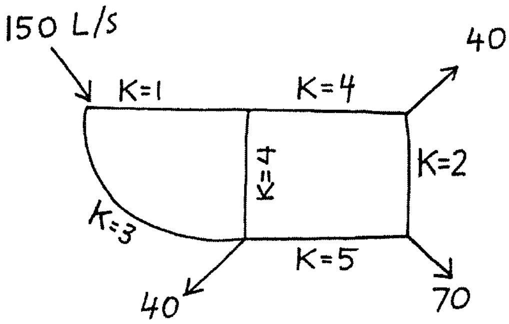
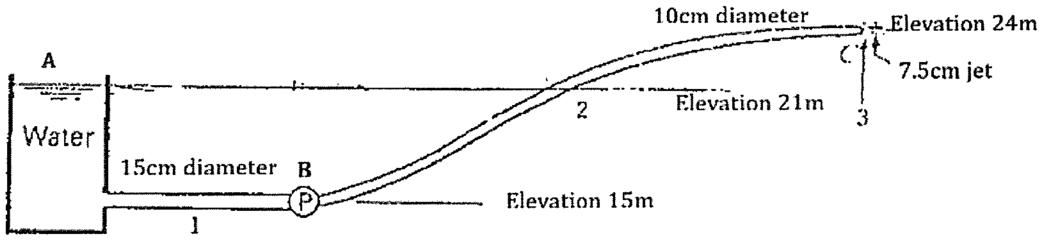


Figure D



Supporting Table & Moody's Diagram

D_2/D_1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
k_c	0.50	0.45	0.42	0.39	0.36	0.33	0.28	0.22	0.15	0.06	0.00