Course Name : Computer Application in Civil Engineering **Couse Code: CIE 405** **Level: 4 th level** **Department: Civil Engineering** **Term No :2**	**Total marks = 60**	**Final Term exam** **Date: 31/5/2023** **Time: 3.0 hours** **No of questions: 3** **No of pages: 2**

Solve all questions, clear and arranged answer is required, assume any missing data.

Question (1) **(C2, a1, c1 – C11, c1)** **[10 marks]**

A. Write True (√) or False (X) without rewriting the questions. (5 marks)

1. **EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps. ( )**
2. **In the Excel program, to refer to the range of cells in column D and rows 10 through 20 use D10:D20 ( )**
3. **If the range A1:A3 contains the values 5, 25, and 38, then the formula =MATCH(38, A1:A3,0) returns the number 2, because 25 is the second item in the range ( )**
4. **In SAP 2000 to define the grids for a frame the grids should be in the X and y plane ( )**
5. **In SAP 2000 before running the truss problem all joints should be fixation released ( )**

B. It is required to design a spread excel sheet for critical depth and critical slope computations. Given channel bottom width b (m); Manning's roughness, n; and volumetric flow rate Q (m^3/s). (Critical depth, $y_c = \sqrt{\frac{q^2}{g}}$, and critical slope, $S_C = \left(\frac{Qn}{A_c R_c^{2/3}}\right)^2$) (5 marks)

Question (2) **(C2, a1, c1 – C11, c1)** **[20 marks]**

1. It is required to write the Excel solver steps (showing objective function, constraint functions, and the Excel solver parameters) to design the following canal cross-section using the data: Given values: discharge, Q = 20 m^3/s; bed slope, So = 10 cm /km, Manning's roughness, n = 0.035; and assume b = 2y. (a) Maximum tractive force approach, use τ_{cr} = 1.2 Pascale ($\tau = \rho g R S_o$), and (b) Maximum permissible velocity approach, use V_{max} = 0.7 m/s. (10 marks)

2. Using EPANET program, write briefly the general steps of the input and analysis of the pipe network shown in Figure 1. All pipes length is 500 m, all nodes elevation is 20 m, and the elevation of the reservoir is 100 m the demand from all nodes (node 1 to node 8) is 50 (L/s). (Assume Hazen William roughness coefficient HW= 100).

(10 marks)

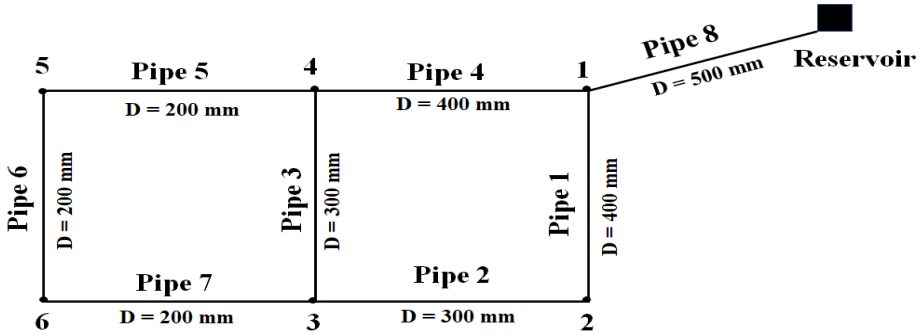
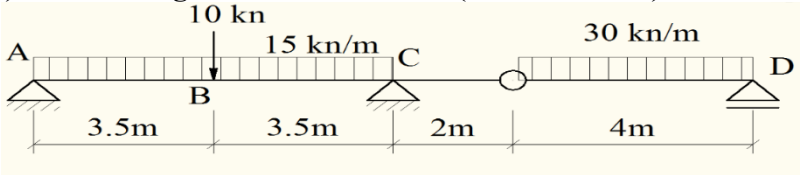


Figure 1. Two-loop water distribution network

Question (3) **(C2, a1, c1 – C11, c1)** **[30 marks]**

1. **Briefly describe how to use SAP 2000 to analyze the loaded reinforced concrete beam (Figure 1) with rectangular cross section of (30 cm x 70 cm) and assume F_{cu}=25 N/mm.**

Figure 1



Sketch the bending moment diagram draw the shown loaded beam and write M_A, M_B and Q_D. (Neglect self-weight of beam). (7 marks)

2. Briefly describe how to use SAP 2000 to analyze and the check design of cross-sections of the following steel truss shown in Figure 2. All members are a double angle back-to-back (70 x 7 mm), use steel 52: Fy = 3600 kg/cm^2, Fu = 5200 kg/cm^2. (Neglect self-weight of members). (8 marks)

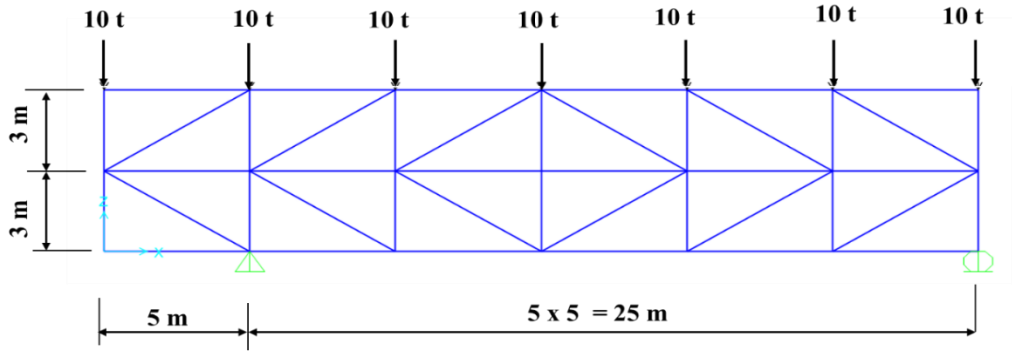


Figure 2. Steel truss project

3. How to use SAP 2000 to analyze the paneled beams project for an area of 9*12 m loaded as shown in Figure 3 (all beams cross-section is 0.3*1.0 m). (Neglect self-weight of the beams). (7 marks)

4. Describe how to use SAP 2000 to analyze the R.C. Flat slab project in Figure 4. The covered area is 15 * 15 m, spacing between columns is 5 m, the marginal beams cross-section is 25*70 cm, and the slab thickness is 20 cm. assume L.L = 2 kN /m^2, and flooring cover 1 kN/m^2. (8 marks)

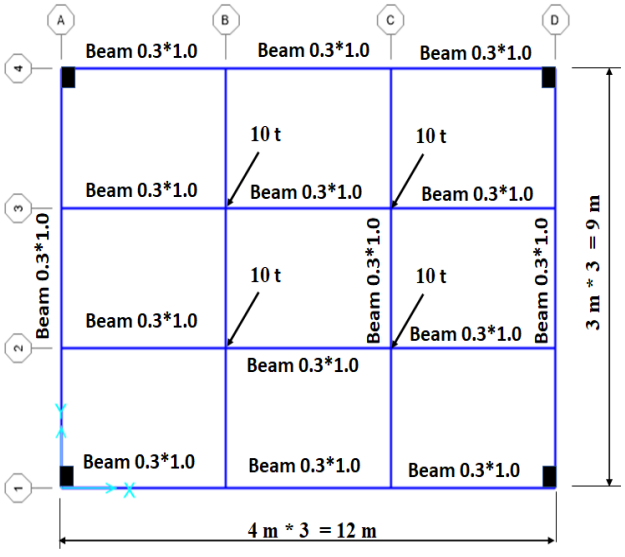


Figure 3. Paneled beam covering project

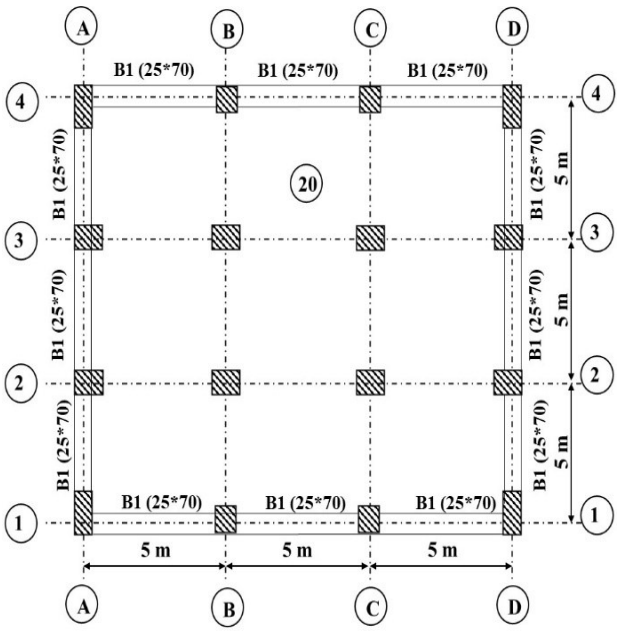


Figure 4. Flat slab project

Best wishes
Assoc. Prof. Dr./ Mohamed Elsayed Gabr

Model Answer

Write True (√) or False (X) without rewriting the questions. (5 marks)

1- (√)
2- (√)
3- (X)
4- (X)
5- (√)

B. It is required to design a spread excel sheet for critical depth and critical slope computations. Given channel bottom width b (m); Manning's roughness, n; and volumetric flow rate Q (m^3/s) (Critical depth, $y_c = \sqrt{\frac{q^2}{g}}$, and critical slope, $S_C = \left(\frac{Qn}{A_c R_c^{2/3}}\right)^2$) (5 marks)

Solution

Open Channel Flow - Critical Depth and Critical Slope Calculation					
1. Rectangular Channel - U.S. Units					
Instructions: *Enter values in blue boxes. Spreadsheet calculates values in yellow boxes*					
Inputs			**Calculations**		
Bottom width, **b** =	4	ft	Critical Depth, y_c =	0.919	ft
Manning roughness, **n** =	0.012		Critical Flow Area, A_c =	3.678	ft^2
Volumetric Flow Rate, **Q** =	20	cfs	Crit. Wetted Perim, P_c =	5.839	ft
			Crit Hydr Radius, R_{hc} =.	0.630	ft
			Crit. Bottom Slope, S_c =	0.00355	
Equations Used for Rectangular Channel Critical Flow Calculations					
$y_c = (q^2/g)^{1/3}$ $(q = Q/b)$					
$A_c = by_c$ $P_c = b + 2y_c$					
$R_{hc} = A_c/P_c$					
$S_c = \left(\frac{Qn}{1.49 A_c R_{hc}^{2/3}}\right)^2$					

Question (2) (C2, a1, c1 – C11, c1) [20 marks]

2. It is required to write the Excel solver steps (showing objective function, constraint functions, and the Excel solver parameters) to design the following canal cross-section using the data: Given values: discharge, Q = 20 m^3/s; bed slope, So = 10 cm /km, Manning's roughness, n = 0.035; and assume b = 2y.

(i) Maximum tractive force approach, use $\tau_{cr} = 1.2$ Pascale ($\tau = \rho g R S_o$) **(5 marks)**
(ii) Maximum permissible velocity approach, use V_{max} = 0.7 m/s **(5 marks)**

Solution

(i) Objective Function is:

$A\,R^{2/3} = \frac{Qn}{\sqrt{S_o}}$

Subject to constraints:

$\tau <= \tau_{cr}$

Or $\tau <= 1.2\,Pa.$

Design flow rate, Q	20	m^3/s
Channel Roughness, n	0.035	
Side slope, t	1.5	
Channel bed slope, S_o	0.0001	
Critical bed shear strength τ_{cr}	1.2	Pascal
Bed width, b		Guess
Water depth, y		Guess
Cross-section area, A		$A = by + ty^2$
Wetted perimeter, P		$P = b + 2\sqrt{(ty)^2 + Y^2}$
Hydraulic Radius, R		A/P
$A\,R^{2/3}$		
$\frac{Qn}{\sqrt{S_o}}$		
Objective Function, difference		$A\,R^{2/3} - \frac{Qn}{\sqrt{S_o}}$
Subject to constraints: $\tau <= \tau_{cr}$	1.2<=	Pa.

Using solver:

Set objective:

$A\,R^{2/3} - \frac{Qn}{\sqrt{S_o}}$

To zero

By changing variable cells b

y

Subject to constraints

b =< 2y

$\tau <= 1.2$

√ Make unconstrained variables non-Negative

Solve

(ii) Maximum permissible velocity approach, use Vmax = 0.7 m/s

Same calculation

Using solver:

Set objective:

$A\,R^{2/3} - \frac{Qn}{\sqrt{S_o}}$

To zero
By changing variable cells b

y

Subject to constraints
b =< 2y
$V = \frac{Q}{A}$ <= 0.5 m/s

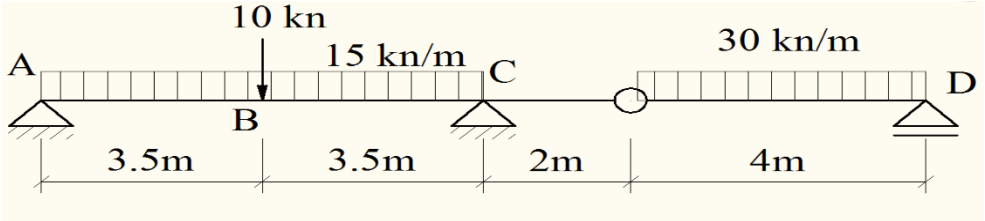
√ Make unconstrained variables non-Negative

Solve

1. Using EPANET PROGRAM, write briefly the general steps of the input and analysis of the pipe network shown in Figure 1 **(10 marks)**
   1- Create a new project in EPANET and make sure that certain default options are selected. (Select File >> New).
   2- Then select the Hydraulics page of the dialog and set the choice of Flow Units to LPS (Liter per second). Also, select Hazen- Williams (H-W) as the head-loss formula.
   3- Select View >> Options to bring up the Map Options dialog form. Select the Notation page on this form and check the settings.
   4- Select View >> Dimensions to bring up the Map Dimensions dialog.
   5- Drawing the Network
   6- Draw the network by making use of the mouse and the buttons contained on the Map Toolbar (View >> Toolbars >> Map).
   7- Setting Object Properties.
   For the reservoir enter its elevation (100) m in the Total Head field.
   For links enter lengths (500 m), diameters for each pipe from the **Figure 1**, and roughness H.W = 100.
   For nodes enter elevations (20 m) and basic demand (50 L/s).
   8- Saving and opining projects.
   9- Running a single period analysis.
   10- Create a tabular listing of results by selecting Report ≫ Table.

<u>Question (3)</u> (C2, a1, c1 – C11, c1) [30 marks]

1. Briefly describe how to use SAP 2000 to analyze the loaded reinforced concrete beam (Figure 1) with rectangular cross section of (30 cm x 70 cm) and assume F_{cu}=25 N/mm. Sketch the bending moment diagram draw the shown loaded beam and write M_A, M_B and Q_D. (Neglect self-weight of beam). (7 marks)



Solution

1- File > New Model > Gird only

Select units (Kn. m. C)

XGrid Data

	Grid ID	Spacing
1	A	3.5
2	B	3.5
3	C	2
4	D	4
5	E	0

YGrid Data

	Grid ID	Spacing
1	1	3
2		

ZGrid Data

	Grid ID	Spacing
1	Z1	1
2		

2- Define Material

Define > material > Select Concrete > Add copy of material > Name material Conc 25

E = $14000*(250)^{0.5}$ = t/m^2, W Unit Weight = 2.5 t/m^3

3- Define frame section

Define > Frame Section > Add Frame section property > Rectangular

Section Name: Beam 0.3*0.7 m

4. Drawing properties

Draw > draw frame

5. Assign > Joint > Restraints

Two Hinged and one simple support

6. Assign > Frame Loads > Point

Force

Code system Global

Direction Gravity

Distance 0 0.5 0

Load 0 25 0

Distributed load 10 KN/m^2

Distributed load 30 KN/m^2

7. Assign > Frame > Release/ Partial Fixity

Moment 3 3 (Major): release (start) release (end)

8. Define > Load Patterns

Self-weight (Dead)- put multiplier = 0

9. Analyze > Run Analysis

Dead linear static Run

Model Don't Run

10. Deformation Shape, check settlement

Shear force 2-2 diagram equal to zero.

Moment force 3-3 diagram

Axial force diagram

2. Briefly describe how to use SAP 2000 to analyze and the check design of cross-sections of the following steel truss shown in Figure 2. All members are a double angle back-to-back (70 x 7), use steel 52: Fy = 3600 kg/cm^2, Fu = 5200 kg/cm^2. (8 marks)

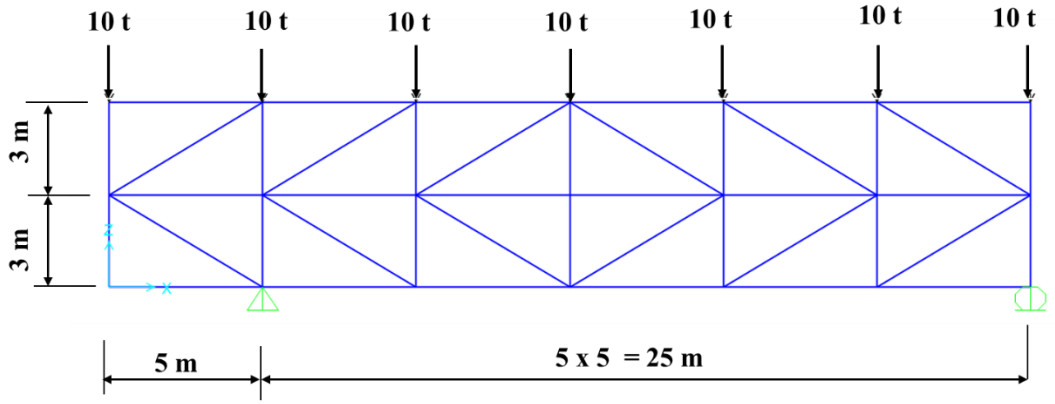


Figure 2. Steel Truss Project

Solution

1- File > New Model > Gird only

Select units (Tonf. M. C)

XGrid Data

	Grid ID	Spacing
1	A	5
2	B	5
3	C	5
4	D	5
5	E	5
6	F	5
7	G	0

YGrid Data

	Grid ID	Spacing
1	1	0

ZGrid Data

	Grid ID	Spacing
1	Z1	3
2	Z2	3
3	Z3	0
4		

2- Define Material
Define > Material > Select steel > Add copy of material > Name material
E = 200000Mpa *100= 20000000 t/m^2, Fy = 36000 t/m^2, Fu = 52000 t/m^2
3- Define frame section
Define > section properties > frame section
Angle 70*7
4. Drawing properties
Draw > draw frame
Use replicate and mirror options
5. Assign > Joint > Restraints
One Hinged and one simple support
6. Assign > Joint Loads > Forces
Load pattern name: dead

Force Global Z = -10

7- Assign > Frame > Release/ Partial Fixity

Moment 3 3 (Major): release (start) release (end)

8- Define > Load Patterns

Self-weight (Dead)- put multiplier = 0

Define > Load Combination

Local combination Name: ultimate

Dead load case type (linear static) scale factor = 1

9. Analyze > Run Analysis

Dead linear static Run

Model Don't Run

10. Deformation Shape, check settlement

Shear force 2-2 diagram equal to zero.

Moment force 3-3 diagram

Axial force diagram

6. **Design > Steel Frame Design > View / Revise References**

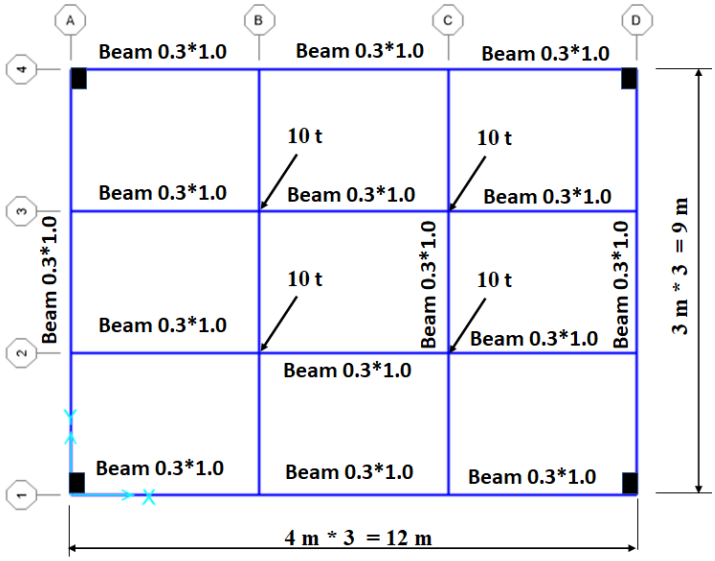
Design > Steel Frame Design > Steel Design Combination

Design > Steel Frame design > Steel Design Check of Structure

القيم اكبر من واحد غير امنة ونحتاج الي قطاع زاوية اكبر الفيم = 1 مثالية القيم اقل من واحد بكثير محتاج تصغر القطاع.

3. Briefly describe how to use SAP 2000 to analyze the paneled beams project for an area of 9*12 m loaded as shown in Figure 3 (all beams cross-section is 0.3*1.0 m). (7 marks)

Solution



Solution

1- File > New Model > Gird only

Select units (Tonf. M. C)

XGrid Data

	Grid ID	Spacing
1	A	4
2	B	4
3	C	4
4	D	0
5		

YGrid Data

	Grid ID	Spacing
1	1	3
2	2	3
3	3	3
4		0

ZGrid Data

	Grid ID	Spacing

1	Z1	1
2		

2- Define Material
Define > material > Select Concrete > Add copy of material > Name material Conc 25
E = 14000*(250)$^{0.5}$ = t/m^2, W Unit Weight = 2.5 t/m^3

3- Define frame section
Define > Frame Section > Add Frame section property > Rectangular
Section Name: Beam 0.3*1.0
4. Drawing properties
Draw > draw frame
Use replicate options
Ctrl > R (dy = -3 (لاعادة رسم الكمرة مرة اخري نختار Replicate أمر
5. Assign > Joint > Restraints
four Hinged supports
6. Assign > Frame Loads > Point
Force

Code system Global

Direction Gravity

Distance 0 0.33 0.667 0

Load 0 10 10 0

7- Assign > Frame > Release/ Partial Fixity

Moment 3 3 (Major): release (start) release (end)

8- Define > Load Patterns

Self-weight (Dead)- put multiplier = 0

9. Assign > Frame > Assign Automatic Mech

At intermediate joints

At intersections with other frames, areas edges and solid edges.

10. Analyze > Run Analysis

Dead linear static Run

Model Don't Run

10. Deformation Shape, check settlement

Shear force 2-2 diagram

Moment force 3-3 diagram

Axial force diagram

4. Describe how to use SAP 2000 to analyze the R.C. Flat slab project in Figure 4. The covered area is 15 * 15 m, spacing between columns is 5 m, the marginal beams cross-section is 25*70 cm, and the slab thickness is 20 cm. assume L.L = 2 kN /m^2, and flooring cover 1 kN/m^2. (8 marks)

Solution:

1- File > New Model > Gird only
Select units (kN. m. C)

XGrid Data

	Grid ID	Spacing
1	A	5
2	B	5
3	C	5
4	D	0
5		

YGrid Data

	Grid ID	Spacing
1	1	5
2	2	5
3	3	5
4		0

ZGrid Data

	Grid ID	Spacing
1	Z1	1
2		

2- Define Material
Define > material > Select Concrete > Add copy of material > Name material
Conc 25
E = 14000*(250)$^{0.5}$ = t/m^2, W Unit Weight = 2.5 t/m^3

3- **Define frame section**
Define > Frame Section > Add Frame section property > Rectangular
Section Name: Beam 0.25*0.7
Define Slab cross-section
Define > Section properties > Area sections > Shell Section Data
Membrane 0.2 m
Bending 0.2 m
4. Drawing properties
Draw > draw frame
Draw rectangular area أمر نرسم عكس اتجاه عقرب الساعة

Divide slab area

Select area
Edit > Edit area > Divide area

5. Assign > Joint > Restraints
four Hinged supports
7. Assign Area uniform load for flooring covering
Load 1

Assign Area uniform live load

2 Gravity

8- Define > Load Patterns

Self-weight (Dead)- put multiplier = 1

10. Analyze > Run Analysis

Dead linear static Run

Model Don't Run

10. Deformation Shape, check settlement

For the marginal beam Shear force 2-2 diagram

Moment force 3-3 diagram

Axial force diagram

For slab

Member force diagram M 11

Member force diagram M 22