



May, 2009

Course title Number: CE265

Second Year

Time allowed: 3 hours

اسم المقرر: نظرية المنشآت-4

السنة الدراسية: الثانية

الزمن: 3 ساعات

ملحوظة: يجب أن يبدأ كل سؤال في صفحة مستقلة مع مراعاة ترتيب الحل

**ANSWER ALL QUESTIONS**

**Question (1)**

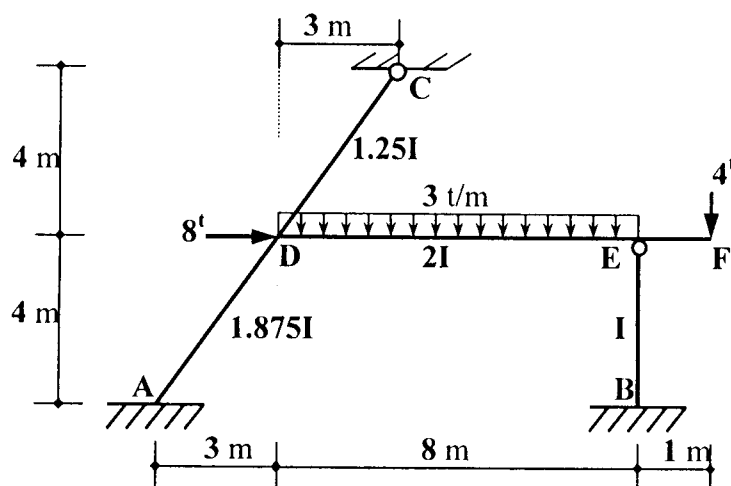
(30 marks)

For the shown indeterminate frame and by using the Moment Distribution Method, it is required to draw the B.M.D due to:

a- The given loads.

b- Uniform rise of temperature of  $25^{\circ}\text{C}$  at member (DE).

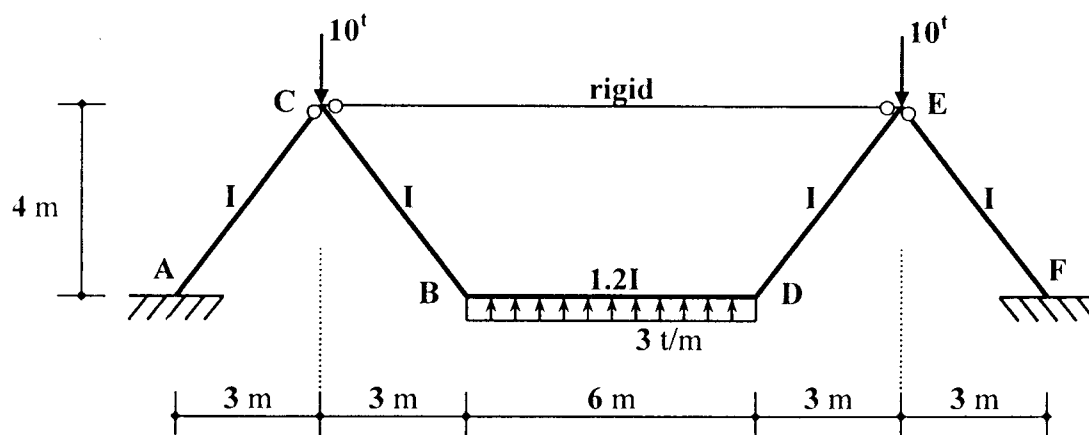
Given that:  $EI = 8000 \text{ t.m}^2$ ,  $\alpha = 1.2 \times 10^{-5}$



**Question (2)**

(20 marks)

For the shown symmetrical indeterminate structure and by using the Moment Distribution Method, it is required to draw the B.M.D, S.F.D and N.F.D.





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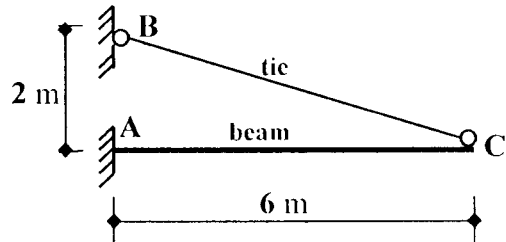
Time allowed: 3 hours

الزمن: 3 ساعات

**Question (3) (20marks)**

For the shown indeterminate beam and by using the Virtual Work Method, it is required to draw the I.Ls of  $F_{bc}$  and the reactions at (A).

Given that:  $EA_{tie} = 10 EI_{beam}$ .



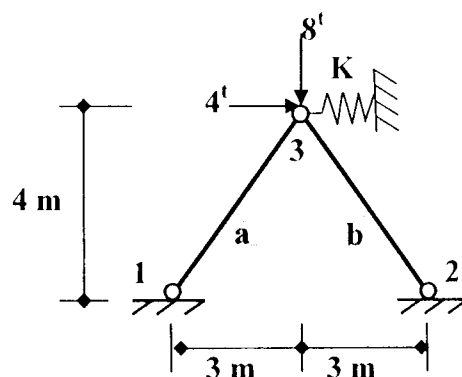
**Question (4) (20 marks)**

For the shown structure and by using the Stiffness Method, it is required to:

- Calculate the internal forces in the structural members.
- Calculate the force in the spring.

Given that:  $EA_{truss\ members} = 40000\ t$

$K_{spring} = 0.2 EA_{truss\ members}$

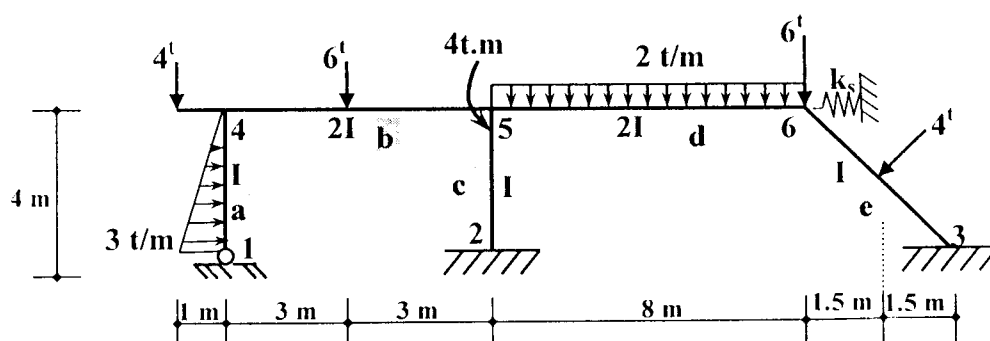


$$\bar{k} = \begin{bmatrix} \frac{EA}{L} & \frac{EA}{L} \\ \frac{EA}{L} & \frac{EA}{L} \end{bmatrix}, \quad R = [c \quad s]$$

**Question (5) (20 marks)**

For the shown frame and by using the Stiffness Method, it is required to:

- Construct the *overall stiffness* matrix of the frame in symbolic form.
- Construct the *load vector* of the structure due to the given loads.



Materials to be used: **concrete:**  $f_{cu}=25\text{MPa}$   
**Steel:** st.360/520 (for longitudinal reinforcement) & st.240/350 (for stirrups)

**Question 1:** (20% of max credit)

Explain the reasons for the following:

1. Steel is a suitable reinforcing material for concrete.
2. The Egyptian Code specifies a maximum value for the tensile reinforcement ratio in sections subjected to bending moments.
3. The allowable working concrete stress for a T-section subjected to bending is reduced to 67% of the corresponding value for a rectangular section.
4. Reinforced concrete columns should be provided with lateral reinforcement.
5. Stirrups used to resist torsion in reinforced concrete beams should be closed stirrups.

Compare between the following (use neat sketches to explain your answers):

6. Elastic and creep deformations in concrete.
7. Flexure failure and bond failure in reinforced concrete beams.
8. Web shear cracks and flexure shear cracks.
9. Behavior of columns with separate stirrups and behavior of spirally reinforced columns.
10. Equilibrium torsion and compatibility torsion.

**Question 2:** (35% of max credit)

1. For the reinforced concrete rectangular section shown in Fig.1, calculate the following:
  - a) Cracking moment.
  - b) Service moment capacity.
  - c) Failure moment.
2. Calculate the reinforcement required for a rectangular section to resist an ultimate bending moment ( $M_u=280\text{ kN.m}$ ) given that the section dimensions are ( $b=250\text{mm}$ ), ( $d=530\text{mm}$ ) and ( $h=600\text{mm}$ ).
3. For the reinforced concrete section shown in Fig.2, calculate the tensile reinforcement required to resist an ultimate moment ( $M_u=350\text{ kN.m}$ ).

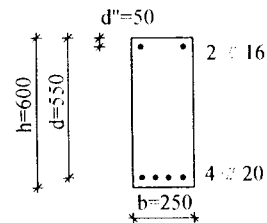


Fig.1

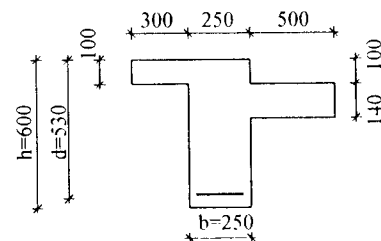


Fig.2

**Question 3:** (10% of max credit)

A reinforced concrete short column has a T-shaped cross section as shown in Fig.3. The column is subjected to axial loads ( $P_{DL}=1400\text{ kN}$  and  $P_{LL}=800\text{ kN}$ ). It is required to:

1. Design the column to resist the applied loads using the ultimate strength design method.
2. Draw a cross section of the column showing all dimensions and reinforcement details (scale 1:20).

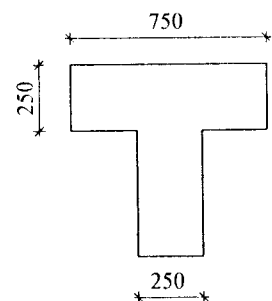


Fig.3

**Question 4:** (35% of max credit)

A reinforced concrete floor consists of a slab and beam system. A typical intermediate beam is simply supported on two columns as shown in Fig.4. The beam has a span ( $L=8.00\text{m}$ ) and the spacing between adjacent beams is ( $S=4.00\text{m}$ ). The beam has a T-shaped cross section for which the thickness of the floor slab is ( $t=120\text{mm}$ ), the width of the beam web is ( $b=250\text{mm}$ ) and the beam depth is ( $d=630\text{mm}$ ). The beam is subjected to a uniformly distributed ultimate load ( $w_u=60\text{kN/m}$ ). For this typical beam it is required to:

1. Draw the bending moment and shearing force diagrams.
2. Design the reinforcement required for bending moment.
3. Design the web reinforcement using vertical stirrups only.
4. If part of the tensile reinforcement is required to be discontinued to the support, determine the maximum amount of the tensile reinforcement that could be terminated a distance ( $1.00\text{m}$ ) from the face of the support (see the given figure).
5. Calculate the minimum required anchorage length beyond the centre of the support for the remaining reinforcing bars extending to the support.
6. Draw complete working drawings (scale 1:25) of the beam showing all dimensions and details of reinforcement.

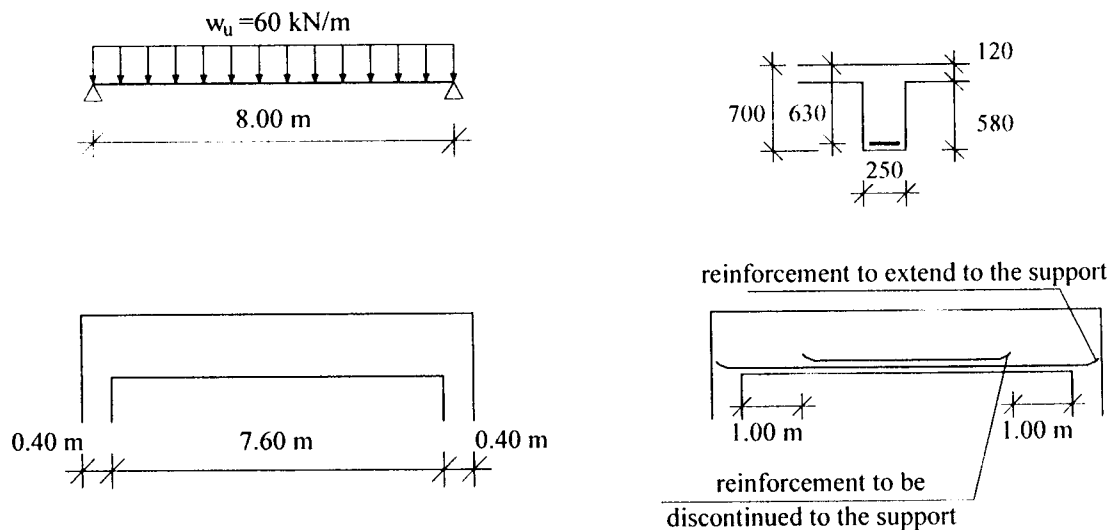
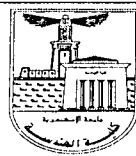


Fig. 4

*Best wishes...*



Time Allowed : 3.0 Hours

الإمتحان مكون من ثلاث صفحات - مطلوب الإجابة على جميع الأسئلة

Answer questions of the following:

**QUESTION ONE**

The hollow closed cylinder of diameter 2.0 m, shown in figure (1), is just submerged in water. Find the magnitude, direction and point of application of the resultant hydrostatic pressure force acting on the end A B for the case of water outside and vapor inside.

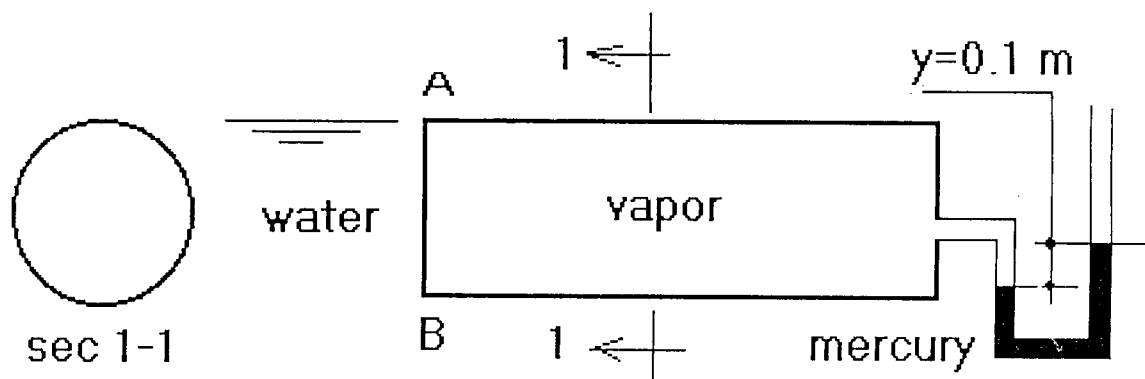


Figure (1)

**QUESTION TWO**

The light floating system ( $S = 0.4$ ), shown in figure (2), is floating in liquid ( $S = 1.2$ ). The length of the system is 2.0 m. You are asked to estimate the weight ( $W$ ) which can be carried above the floating system so that the draft does not exceed 0.3 m.

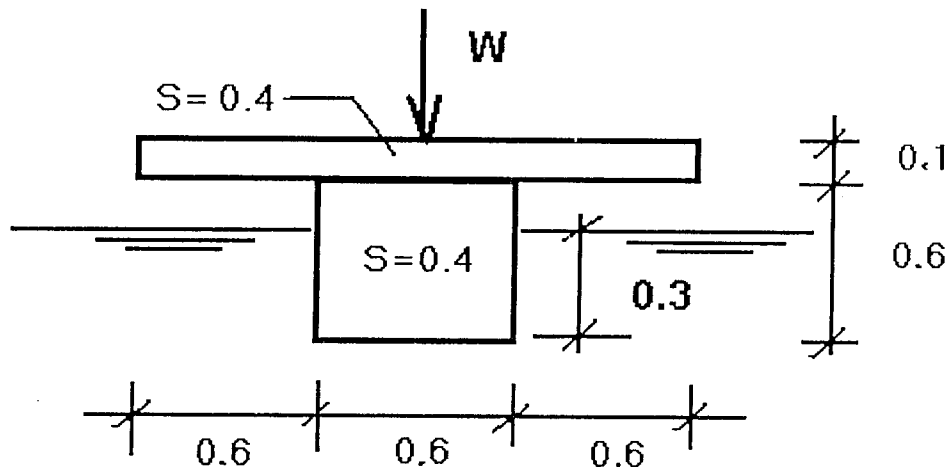


Figure (2)

### QUESTION Three

For the pipe shown in Figure 3, apply energy equation between 1 & 2 neglecting losses to determine the passing discharge. Draw TEL and HGL for the pipe between 1 & 2.

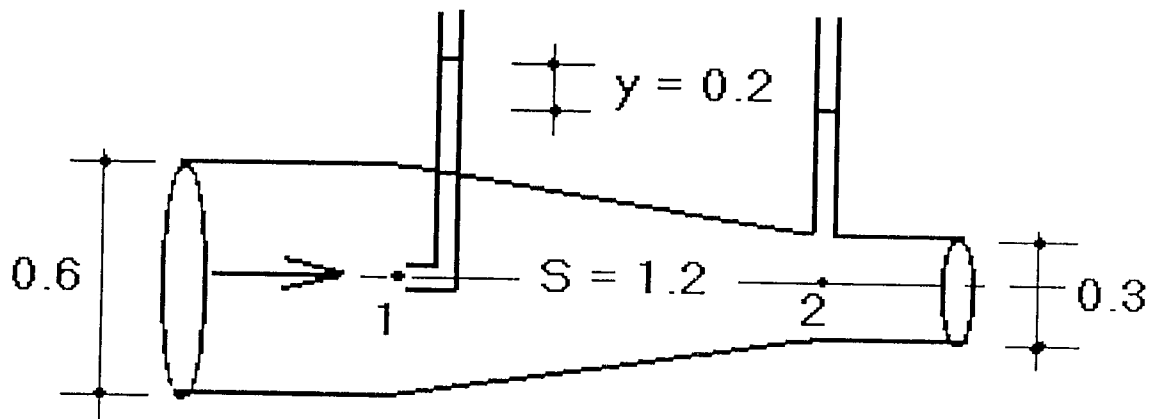


Figure (3)

### Question Four

- Derive the discharge equation for the large rectangular orifice.
- Derive a relationship for the velocity distribution for the case of laminar flow in pipes.
- Derive the discharge equation for the flow in a venturi-meter.

### Question Five

The inlet and throat diameters of a venturi-meter are 30 cm and 20 cm, respectively. If the coefficient of discharge is 0.98 and the passing discharge of water is 150 Lit/sec. Without derivation, find the deflection for the following two cases (Draw sketches):

- The manometer liquid has  $S = 1.6$ .
- The manometer liquid has  $S = 0.8$ .

### Question Six

Figure (4) shows a siphon pipe ABC. Using energy equation, show that the velocity of flow passing in the pipe depends on  $H_C$ , while the pressure at the top of pipe depends on both  $H_B$  and  $H_C$ . Consider the diameter of pipe is 15 cm, velocity through pipe is 3.0 m/s and the minimum absolute pressure in the pipe is  $3.0 \text{ t/m}^2$ , find the discharge, the height  $H_B$ , and height  $H_C$ , neglect energy losses. Draw T.E.L. & H.G.L. Show two different methods to double the flow of water.

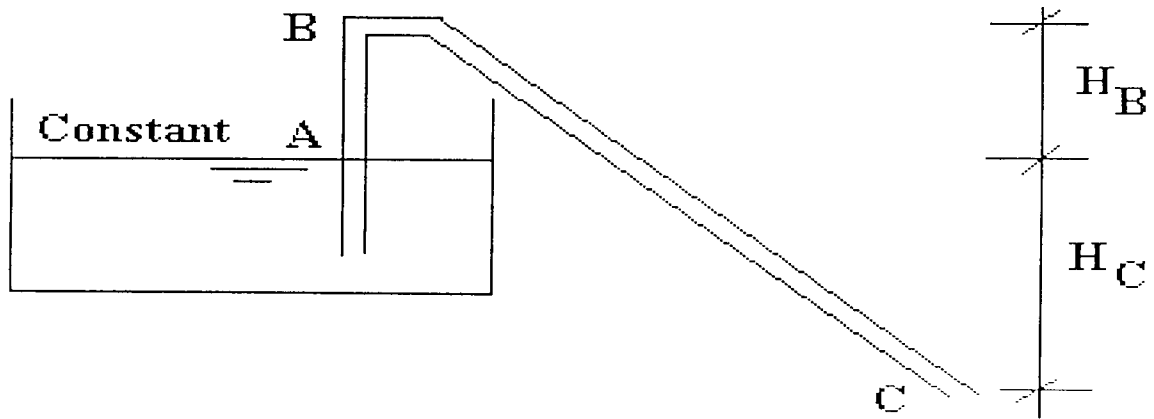


Figure (4)

Question Seven

In Figure (5), for one meter width, find the discharge for the following cases:

1.  $Y_{us} = 3.50 \text{ m}$  ,  $Y_{ds} = 1.0 \text{ m}$  ,  $a = 1.0 \text{ m}$
2.  $Y_{us} = 3.50 \text{ m}$  ,  $Y_{ds} = 2.5 \text{ m}$  ,  $a = 1.0 \text{ m}$
3.  $Y_{us} = 3.00 \text{ m}$  ,  $Y_{ds} = 2.5 \text{ m}$  ,  $a = 2.0 \text{ m}$

Assume constant  $C_d = 0.62$

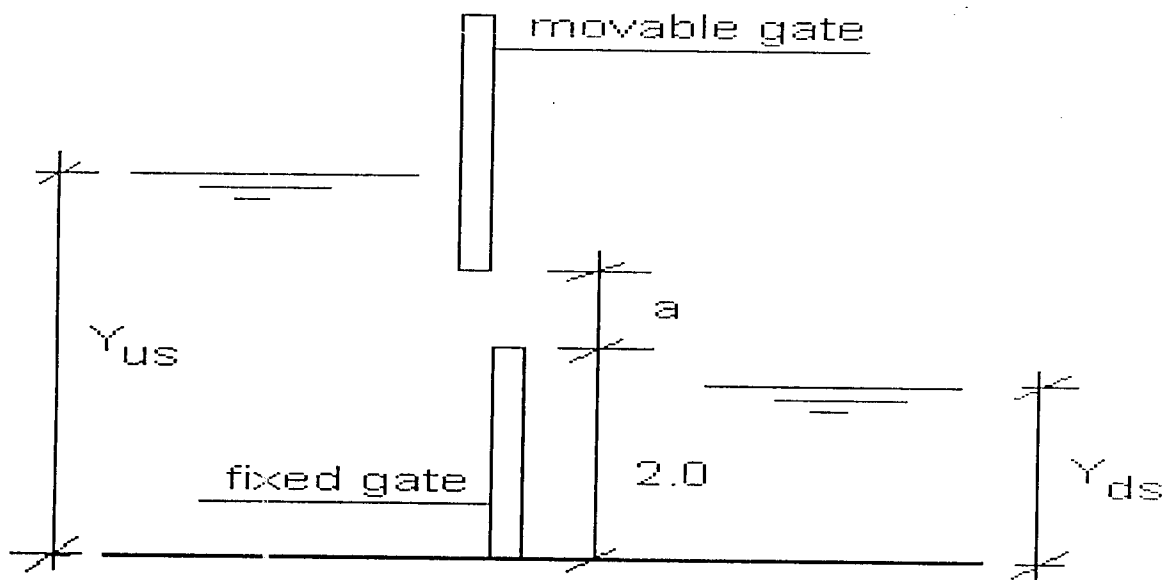


Figure (5)

Prof. Dr. Hossam M. Nagy

Prof. Dr. Essam Awad Mostafa

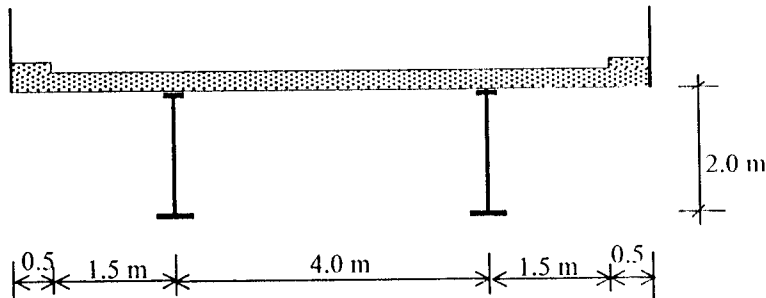


The number of pages of this exam is TWO only.

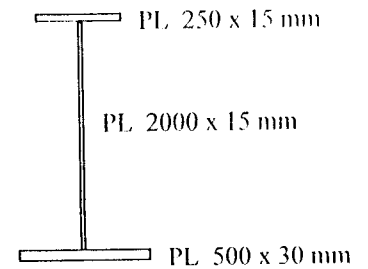
The students are allowed to use: Steel Code and Tables.

### PART I (55%)

The Figure shows the cross-section of a simply supported road bridge. The bridge has two composite main girders 28.0 m span.



Bridge Cross-Section



Main girder cross section

#### Given:

Weight of steel = 100 kg / m<sup>2</sup>

Weight of pavement = 200 kg / m<sup>2</sup>

R.C slab thickness = 30 cm  $F_{cu} = 400 \text{ kg/cm}^2$

The live load and impact should be considered according to the Egyptian Code requirements.

St (52) should be used High Strength Bolts M 30 (10.9)

#### Required:

يجب إجابة السؤال الأول في لوحة الرسم المرفقة مع كراسة الإجابة

1- Draw to scale 1:200 the bracing system required for the bridge (3 views). Explain how the horizontal load are transmitted to the bearings. (13 %)

2-Compute the maximum design bending moment and shearing force for the composite main girder.(12 %)

3-Check the safety of the given section of the composite main girder (assume un-shored construction). (17 %)

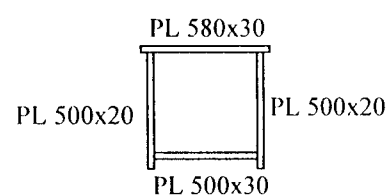
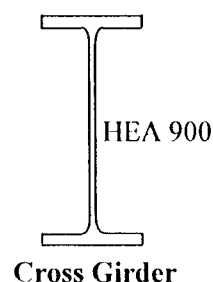
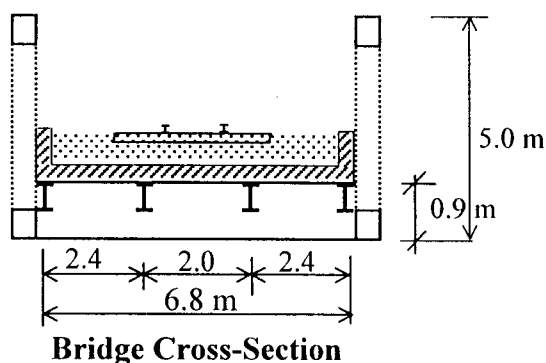
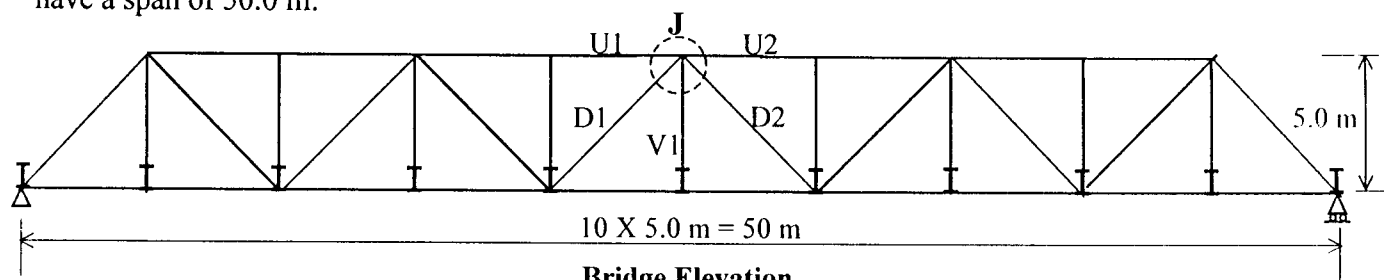
4- Compute the spacing of the shear connectors. Consider stud shear connectors with 20 mm diameter . (5 %)

5- Design the elastomeric movable bearing of the bridge. (8 %)



## PART II (55%)

The Figure represents the elevation and the cross-section of a ballasted floor railway truss bridge have a span of 50.0 m.



### Given:

Weight of steel = 200 kg / m<sup>2</sup> (for main girder design)

Ballast thickness = 50 cm ( $\gamma = 2.0 \text{ t/m}^3$ )

R.C slab thickness = 20 cm

Impact Coefficient  $I = 0.8 (24 / (24 + L))$

Live load = Equivalent uniform load 3.0 t / m<sup>2</sup>

Wind load should be considered according to the Egyptian Code requirements

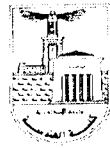
St (52) should be used High Strength Bolts M 30 (10.9)

Gusset plate thickness = 20 mm

### Required:

يجب إجابة السؤال الرابع في لوحة الرسم المرفقة مع كراسة الإجابة

- 1- Calculate the maximum design force for the truss member U1. (5 %)
- 2- Compute the in-plane and out-of-plane buckling lengths of the truss member U1, then check its safety for the given section. (12%)
- 3 - Calculate the internal forces in the vertical member V1 due to the effects of the vertical and the horizontal loads , then check its safety for the given section. (10 %)
- 4- Design the truss joint "J", then draw to scale 1:10 the elevation of the joint. (18 %)
- 5- Check the safety of the intermediate stringer as a simple beam (IPE 600) according to the LRFD Code requirements. (10 %)



Answer the following seven questions. All figures are shown in pages 3/4 & 4/4.

**QUESTION (1) (30 marks)**

- A. Explain the difference between each of the following pairs :
- 1- Pizometers and manometers.
  - 2- Center of pressure and center of gravity.
  - 3- Stable equilibrium and Neutral equilibrium.
  - 4- Free overfall weir and submerged weir.
  - 5- Lower critical velocity and upper critical velocity.
  - 6- Pump Head and Turbine head.
- B. Derive a relationship for the velocity distribution for the case of laminar flow in pipes, then prove that the maximum velocity is twice the mean velocity.
- C. Derive a relationship for each of the following :
1. The discharge equation for the flow in a venturi-meter.
  2. The discharge equation for flow through free large rectangular orifice.
- D. Neglecting minor losses, give neat sketches showing the total energy line for the following cases:
1. Three pipelines of diameters  $d_1$ ,  $d_2$ ,  $d_3$  in series connecting two tanks,  $d_1 < d_2 > d_3$ .
  2. A pipeline connecting two tanks with a small hole in the middle.
  3. Four tanks connected by four pipes having a common junction.

**QUESTION (2) (15 MARKS)**

- 1- Calculate the minimum weight ( $W$ ) of the circular gate BC shown in figure (1), required to keep the gate just closed, for a maximum water height of 4.0 m at the upstream.
- 2- For the gate AB shown in Fig. (2), determine the pressure distribution at the gate if the vessel is moving:
  - a) Vertically upward with an acceleration  $4.9 \text{ m/sec}^2$ .
  - b) Horizontally to the left with an acceleration  $3.27 \text{ m/sec}^2$ .
  - c) The Force  $F_B$  is given to keep the gate vertical, find the acceleration and its direction so that the force  $F_B$  vanishes.

**QUESTION (3) (5 MARKS)**

The inlet and throat diameters of a venturi meter are 30 cm and 20 cm, respectively. The inlet lies 50 cm above the throat. If the coefficient of

discharge is 0.98, the pressures at inlet and throat are  $(0.3) \text{ kg/cm}^2$  and  $(-0.15) \text{ kg/cm}^2$ , respectively. By applying the energy equation, find the discharge.

**QUESTION (4) (15 marks)**

Determine the magnitude and direction of the resisting force required to fix the pipe connection shown in figure 3. (The pipe is in horizontal plane, the pressure at point (B) is  $1.6 \text{ kg/cm}^2$ .)

**QUESTION (5) (15 MARKS)**

Water is flowing from tank (A) to tank (B) through a V-notch ( $\theta = 90^\circ$ ,  $C_d = 0.60$ ) then flows to tank (C) through an orifice ( $d = 25 \text{ cm}$ ,  $C_d = 0.60$ ). For constant water levels in tanks (A), (C) as shown in figure (4), find the discharge and water level in tank (B).

**QUESTION (6) (20 MARKS)**

For the shown hydraulic system in figure (5), if the pressure at point "D" is  $7.0 \text{ ton/m}^2$  and the discharge at the same point is  $0.055 \text{ m}^3/\text{sec}$ . (consider the friction coefficient "f" for all pipes is 0.02 and neglect all minor losses)

- 1- Determine the pipe diameter ( $d$ ) shown in the figure.
- 2- Draw sketch for the T.E.L for the pipes ABCD.

**QUESTION (7) (20 marks)**

For the pipe network shown in figure ( 6 ), find the discharge at ( E ) and then find the discharge in each pipe.

*Good Luck*

**Prof. Dr. Hossam Nagy**

**Prof. Dr. Essam Awad**

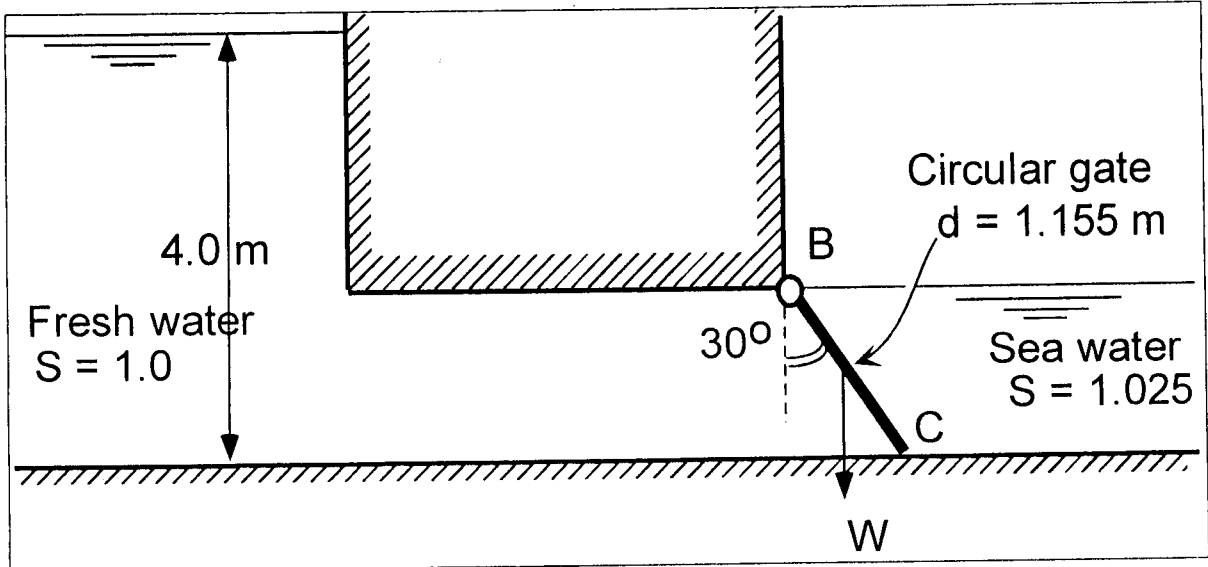


Figure (1)

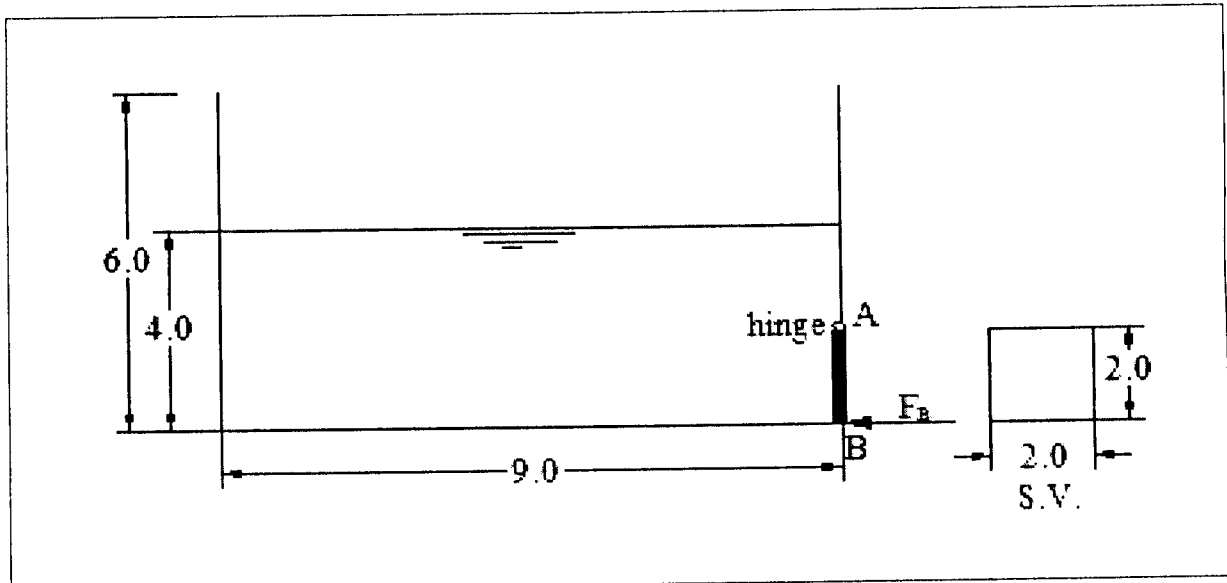


Figure (2)

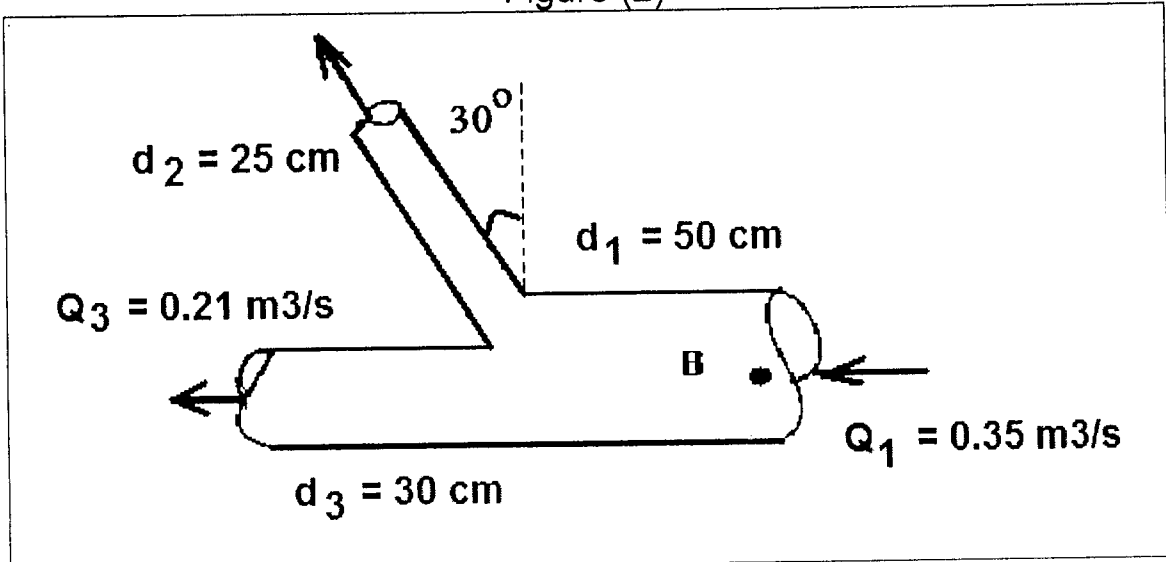


Figure (3)

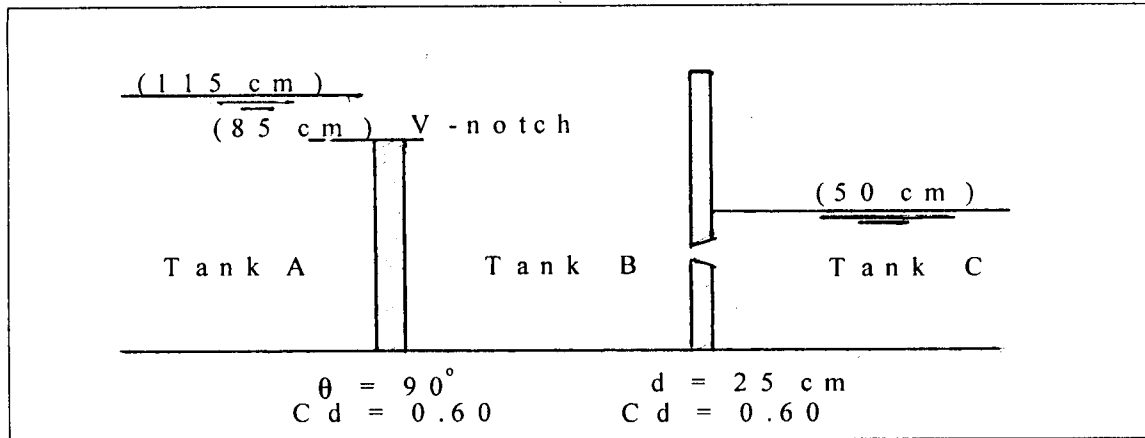


Figure ( 4 )

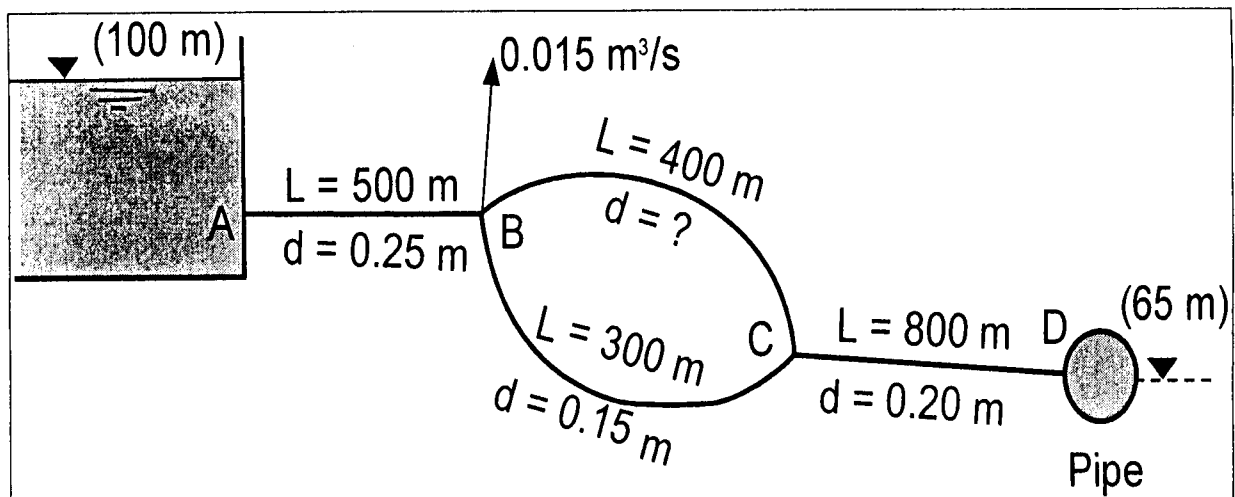


Figure ( 5 )

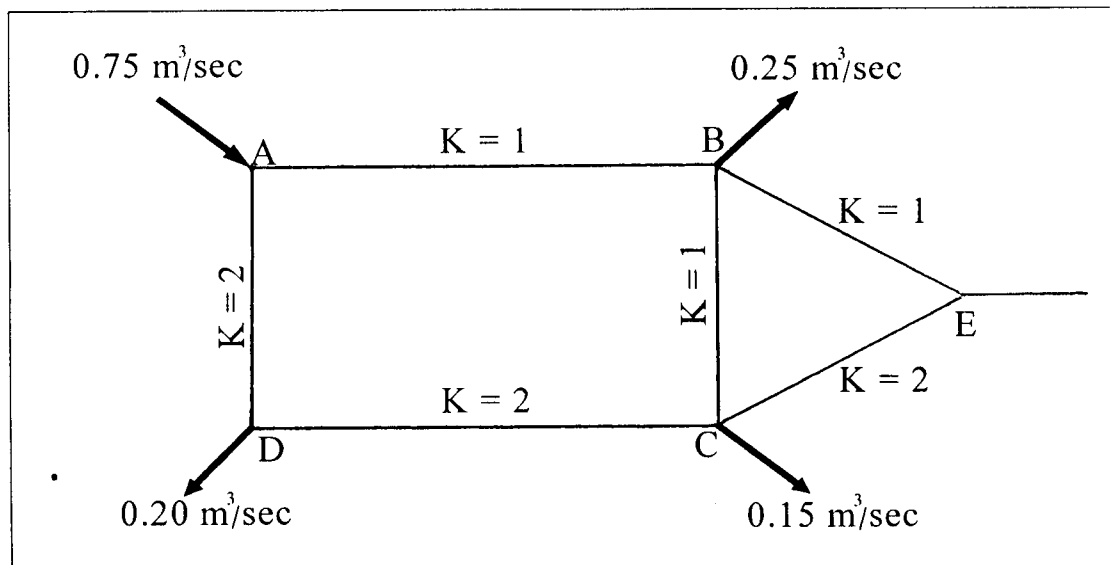


Figure ( 6 )