Final Exam (3rd Year Civil Eng.)
Structural Analysis & Mechanics III

Date: Saturday 3 June 2016
Total Grade: 100 Points (100P)

Time: 09:30am – 12:30pm
Instructor: Professor: Mohamed EL-Assaly
Dr. Ahmed M. EL-Kholy , Lecturer

Notes: **1. Four Aids:** *1-Appendices C & D (Ghali Book, Pages 778-783), 2-Appendix 11.2 (EL-Behairy Book, Pages 42-45), 3-APPENDIX S (One paper × two sides)* and *4-APPENDIX F (One paper ×two sides).*
2. The aids must be completely clean from any added data.
3. Answer must be neat, specific, and in order. Highlight the main steps and results.
4. Ruler and reasonable scales must be used for drawings and diagrams.
5. Start each question in a new page. Answer each question Q in one ~ two pages *if possible*.
6. Write the final values of matrices elements in intact form IF NO multiplier (factor) is specified.

12P Q.1. Without calculations, show the steps of analyzing the highly statically indeterminate frame shown in **Fig. 1** to draw BMD using reduction theory, advantage of symmetry, column analogy method and consistent deformation method.

23P Q.2. Use the Matrix Force Method to find the forces in the members of the truss shown in **Fig. 2-a.** Use the primary system given in **Fig. 2-b** and use the given numbering for elements. EA is constant for all members and equal to 10500 t.

11P Q.3. Use the Matrix Force Method to perform the main steps required for analyzing the beam shown in **Fig. 3**. EI=4000 tm^2 and the flexibility constants of axial and rotational springs are f_l=0.001 m/t and f_r=0.002 rad/mt, respectively. Use cantilever primary system and replace the springs with unknown forces X_1 and X_2. Calculate the **Mp** vector, **Mq** matrix and **Fu** matrix. Also, calculate $\mathbf{\Delta^*}$ vector in the compatibility condition $\mathbf{\Delta+FX= \Delta^*}$.

Hint: Use cantilever main system. Estimate ONLY **Mp**, **Mq**, **Fu** and $\mathbf{\Delta^*}$.
Do not make non-required steps such as finding Δ, F, X and BMD.

25P Q.4 Use the Displacement Method (Whole Approach) to find the displacements at **B** and **C** for the frame shown in **Fig. 4** under the illustrated loads in which P=2 t and L=5 m. Also, draw the BMD for the girder **BC** only. The frame has constant EI. Neglect the axial deformation.

Hint: Displacements values have multiplier equal to (1/EI).

40P Q.5. Use Matrix Displacement Method (Assemble Approach) to re-analyze the frame shown in **Fig. 4**. However, take axial deformation into consideration in this time. E=2×10^6 t/m^2, I=5×10^{-3} m^4 and A=0.10 m^2. Use the shown element numbering. Find the followings:

- DOF considering axial deformation.
- The elements stiffness matrices in local coordinates. "*take 80=EI/125 as multiplier for matrices of elements 2 and 3, and 156.25=EI/64 as multiplier for the matrix of element 1*"

- Local-global element transformation matrices.
- The elements stiffness matrices in global coordinates.
- Variable-Correlation table.
- The first column of structure stiffness matrix. (by assemble)
- The BMD for ONLY girder **BC**. "*Given that the final displacements at **B** (U_x, U_y, θ_z) = (-0.00132 m, -0.0001062 m, -0.0003104 rad) and at **C** (U_x, U_y, θ_z) = (-0.00139 m, -0.00115 m, 0.0004544 rad)*".

<u>Hint</u>: Only the first column of structure stiffness matrix is required. Displacements values are given and no solution of equation is required.

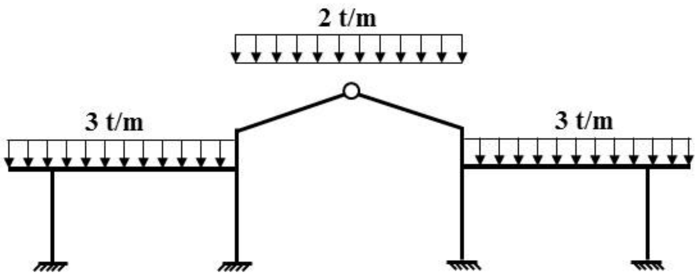

Fig. 1

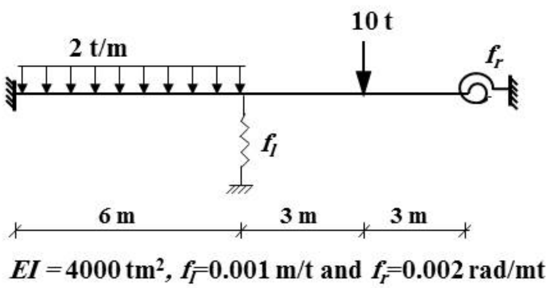

Fig. 3

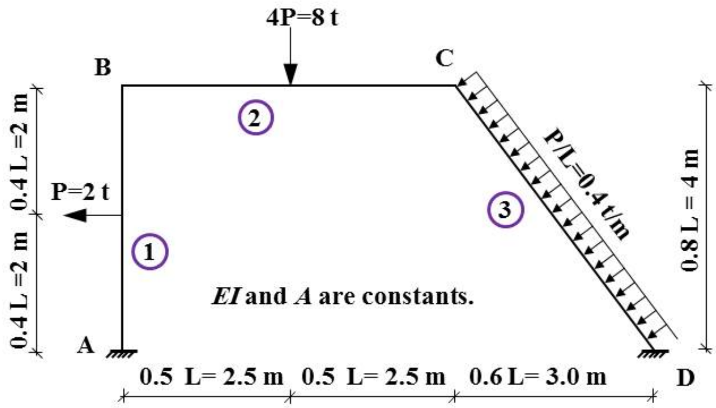

Fig. 4

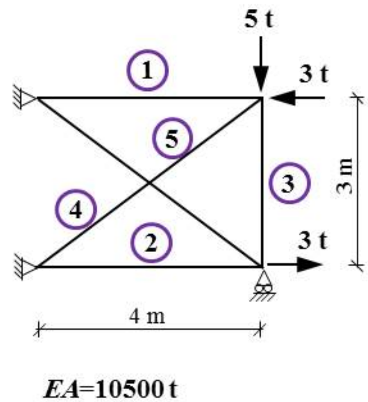

Fig. 2-a

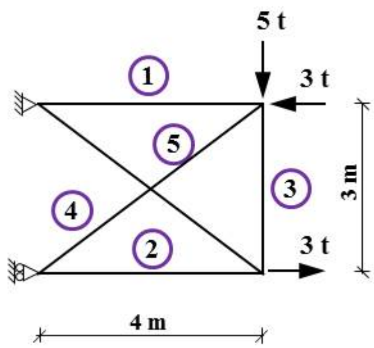

Fig. 2-b