注意：考試開始鈴響前，不得翻閱試題，
並不得書寫、畫記、作答。

國立清華大學 114 學年度碩士班考試入學試題

系所班組別：動力機械工程學系
丙組(固體與奈微米力學組)

科目代碼：1401

考試科目：材料力學

—作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「▼ 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

國立清華大學 114 學年度碩士班考試入學試題

系所班組別：動力機械工程學系碩士班　丙組(固體與奈微米力學組)

考試科目（代碼）：材料力學(1401)

1. Two conceptual problems (1.1 and 1.2):

1.1. **[15 Points]** Refer to Fig. 1. The points A, B, and C are located in a beam subjected to the vertical load F, and the points D and E are located in a thin-wall pressure vessel subjected to the internal pressure p. The state of stress of each point is represented by a Mohr's cycle with the principal stresses $\sigma_1 \geq \sigma_2 \geq \sigma_3$. Answer the following questions:

(1) Identify the Mohr's circle (No.1 – No.6) that represents the state of stress at point A.

(2) Identify the Mohr's circle (No.1 – No.6) that represents the state of stress at point B.

(3) Identify the Mohr's circle (No.1 – No.6) that represents the state of stress at point C.

(4) Identify the Mohr's circle (No.1 – No.6) that represents the state of stress at point D.

(5) Identify the Mohr's circle (No.1 – No.6) that represents the state of stress at point E.

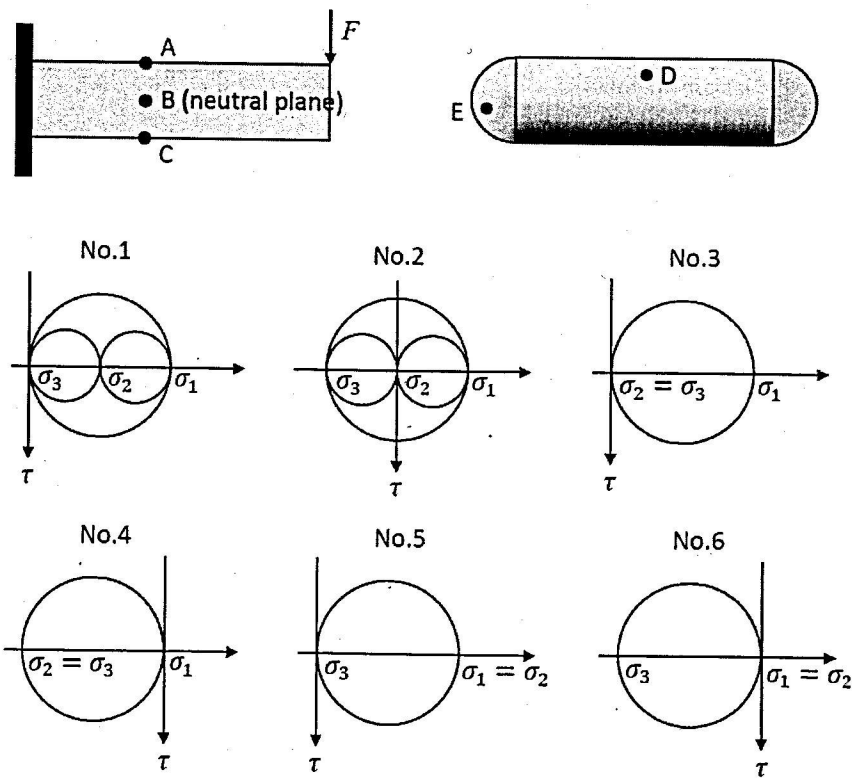

Fig. 1

1.2. **[10 Points]** The roof beams of a warehouse are supported by pipe columns, as shown in Fig. 2. Each pipe column has a diameter *D*, a length *L*, Young's modulus *E*, and a fixed support at the base. Determine the **critical buckling load** for one of these columns under the following assumptions: (a) the upper end is pinned and the beam prevents horizontal displacement; (b) the upper end is fixed against rotation and the beam prevents horizontal displacement; (c) the upper end is pinned but the beam is free to move horizontally; (d) the upper end is fixed against rotation but the beam is free to move horizontally. Answer the following questions:

(1) Which assumption ((a)-(d)) results in the greatest critical buckling load?
(2) Which assumption ((a)-(d)) results in the second greatest critical buckling load?
(3) Which assumption ((a)-(d)) results in the third greatest critical buckling load?
(4) Which assumption ((a)-(d)) results in the smallest critical buckling load?

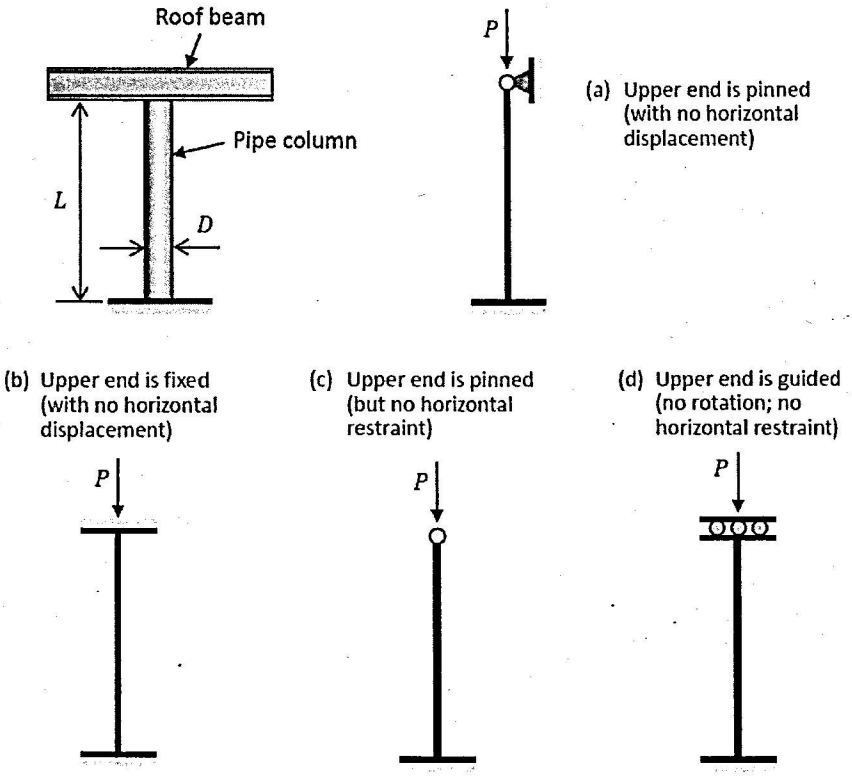

Fig. 2

2. **[25 Points]** Refer to Fig. 3. The assembly consists of three simply supported beams for which the bottom of the top beam rests on the top of the bottom two. If a uniform load of 3 kN/m is applied to the top beam, determine the vertical reactions at each of the supports (A, B, C, D, E, F). The flexural rigidity *EI* is constant.

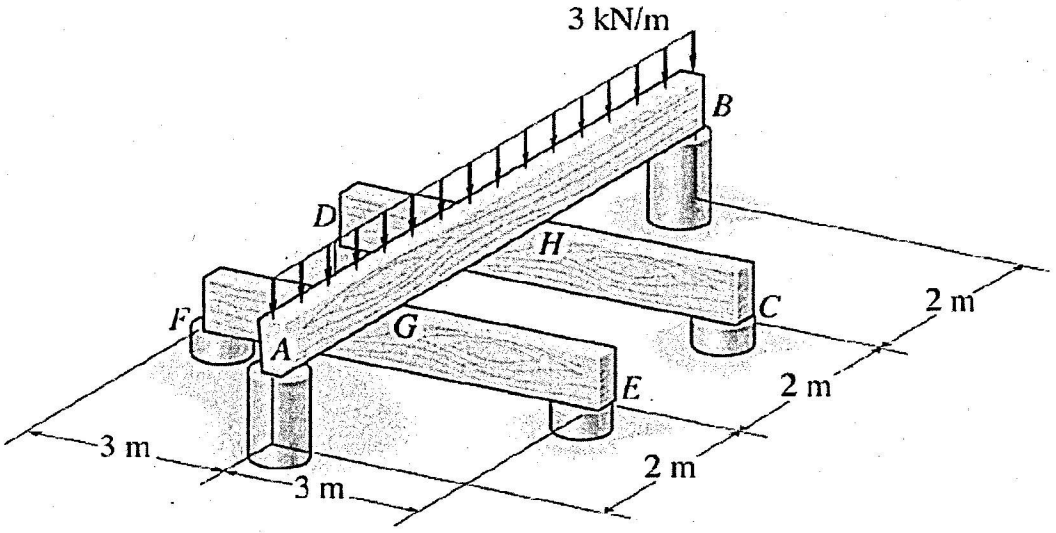

Fig. 3

3. **[25 Points]** A simply supported beam, as shown in Fig. 4, is 12 m long and supported by a pin joint at B and a roller joint at D. Based on the given loads, **develop the shear force (unit: N) and bending moment (unit: N·m) diagrams for the beam**. Indicate the numerical values at points A to F, as well as the maximum and minimum values, on both the shear force and bending moment diagrams, respectively.

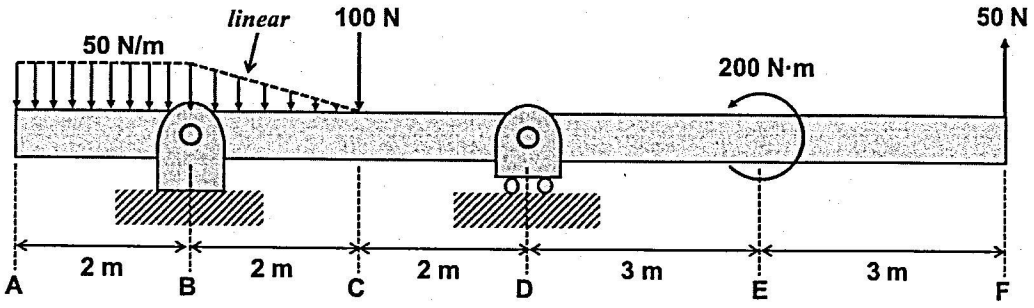

Fig. 4

4. **[25 Points]** Refer to Fig. 5. A rigid bar is pinned at its left end and is pinned to two elastic beams, Beam 1 and Beam 2, at the middle and the right end, respectively. For Beam 1, the length, Young's modulus, cross-sectional area, and coefficient of thermal expansion are denoted as L, $2E$, 2A, and α, respectively. For Beam 2, the length, Young's modulus, cross-sectional area, and coefficient of thermal expansion are denoted as $2L$, E, A, and α, respectively. A point load F is applied to the rigid bar at a position L away from the right end, directed in the negative Y-direction. The temperature of Beam 2 is increased by a temperature change of ΔT, while the temperature of Beam 1 remains constant. Assume *small rotations* of the rigid bar and that *no heat conduction* occurs between the beams. **Determine the axial stresses in Beam 1 and Beam 2**. Express your answers in terms of F, L, E, A, α, and ΔT.

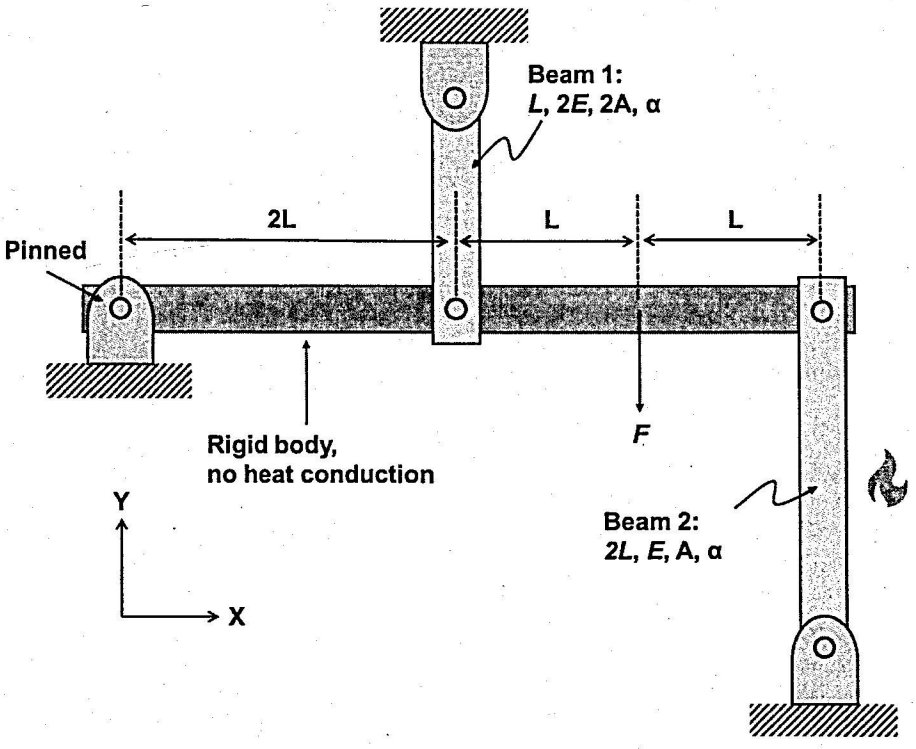

Fig. 5