※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

(1) A statically indeterminate beam, under the point loads (P_0 and M_0) at point B, is shown in Fig. 1 k_s, EI and L denote the spring coefficient, the bending rigidity and the length, respectively ($k_s = \frac{3EI}{L^3}$ and EI=constant). Determine the spring force

(a) using Castigliano's second theorem (select the spring force as the redundant force) , (13%)

(b) using the method of consistent deformations (select the spring force as the redundant force), (13%)

(c) using the slope-deflection method, (12%)

(d) using the moment distribution method. (12%)

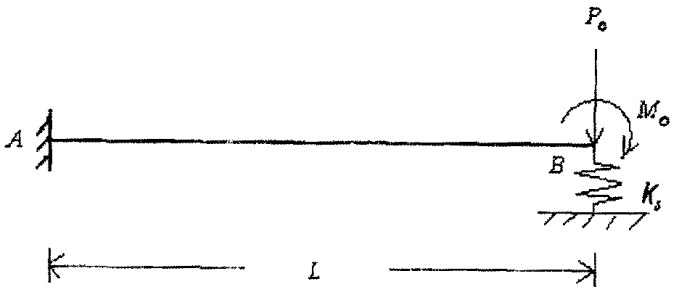

Fig. 1

(Continued)

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(2) Consider the same problem as described in Problem (1). Determine the spring force using the matrix displacement method. According to the global and local coordinate systems, the sets of nodal displacements and forces are defined as ($D_i\ (i=1\sim4)$ and $Q_i\ (i=1\sim4)$) and ($d_i\ (i=1\sim4)$ and $q_i\ (i=1\sim4)$), respectively, and are shown in Fig. 2(a) and 2(b). In addition, the relationship between the nodal displacements ($d_i\ (i=1\sim4)$) and forces ($q_i\ (i=1\sim4)$) for a beam element is given as follows: (20%)

$$\begin{bmatrix} \frac{12EI}{L^3} & \frac{6EI}{L^2} & -\frac{12EI}{L^3} & \frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{4EI}{L} & -\frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{12EI}{L^3} & -\frac{6EI}{L^2} & \frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{2EI}{L} & -\frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix} \begin{bmatrix} d_1 \\ d_2 \\ d_3 \\ d_4 \end{bmatrix} = \begin{bmatrix} q_1 \\ q_2 \\ q_3 \\ q_4 \end{bmatrix}$$

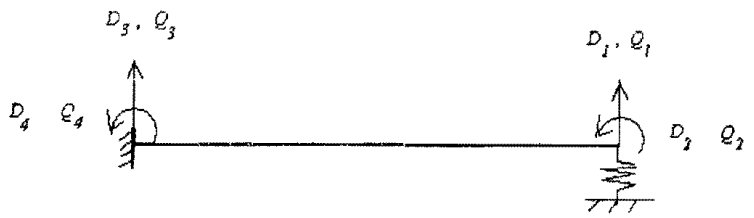

Fig. 2(a): The nodal displacements and forces defined according to the global coordinate system.

Fig. 2(b): The nodal displacements and forces defined according to the local coordinate system.

(3) A statically determinate beam with simple supports is subjected to a uniform load and shown in Fig. 3. Determine the deflection function $w(x)$ of the beam

(a) using the conjugate-beam method, (15%)

(b) using the method of virtual work (or called the unit load method). (15%)