Name: ..........................................

# Ph.D. Preliminary Examination

## Analysis

**Note**:

1. Dimensions, properties and loading are given in consistent units in all problems.
2. All figures are drawn to scale.
3. Calculations should be shown in detail with all intermediate steps; it is recommended to manipulate expressions symbolically as far as possible and substitute numbers only at or near the end.
4. Results involving multiplication or division with a matrix larger than 2 x 2 will not receive credit.

**1. Problem (50% weight)**

The continuous beam over two spans of equal length $L$ in Fig. 1 has a flexible middle support with axial stiffness $k_s$. It is subjected to a vertical force $P_v$ at the middle of the second span. The beam has uniform flexural stiffness $EI$.
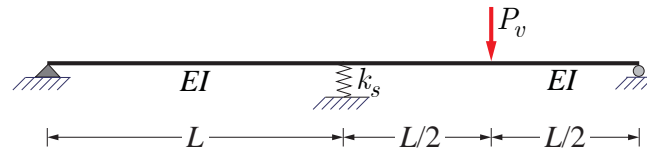


Figure 1: Continuous beam with flexible middle support

You are asked to answer the following questions:

1. What is the value of the spring stiffness $k_s$ in terms of the span length $L$ and the flexural stiffness $EI$, if the axial force in the spring is 65% of the applied force $P_v$?

2. For the spring stiffness value of the preceding question determine the vertical translation at the point of load application.

**2. Problem (50% weight)**

The structural model in Fig. 2 consists of 2 *inextensible* frame elements a and d with flexural stiffness
$EI$ and of 2 *inextensible and inflexible* elements b and c. The structure is subjected to a uniformly
distributed load $w$ of 10 units in elements a and b, as Fig. 2 shows.

You are asked to answer the following questions:

1. Determine the vertical translation at node 2 in terms of $EI$.
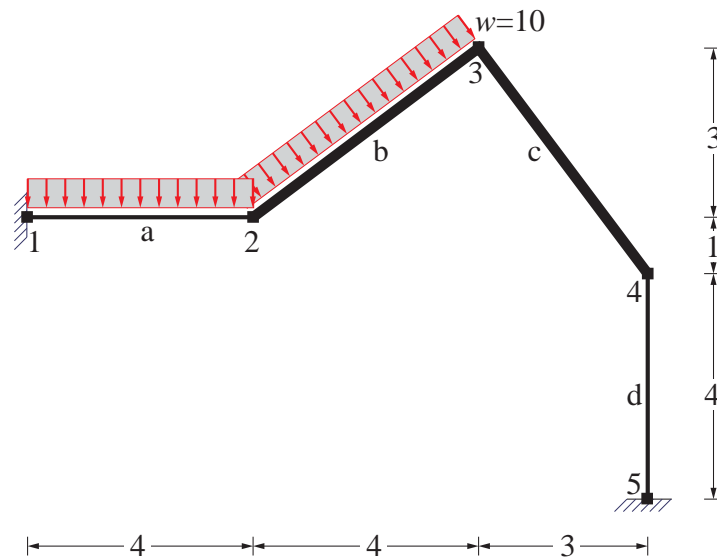2. Draw the bending moment diagram under the given loading.



Figure 2