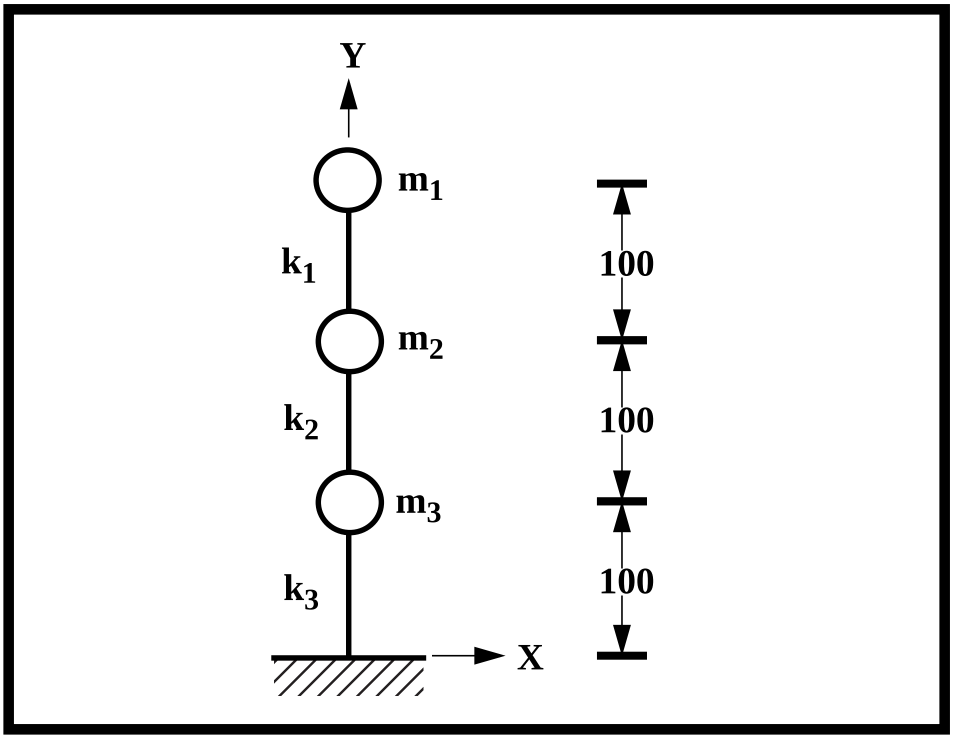
APPENDIX F

Simple Lumped Mass System

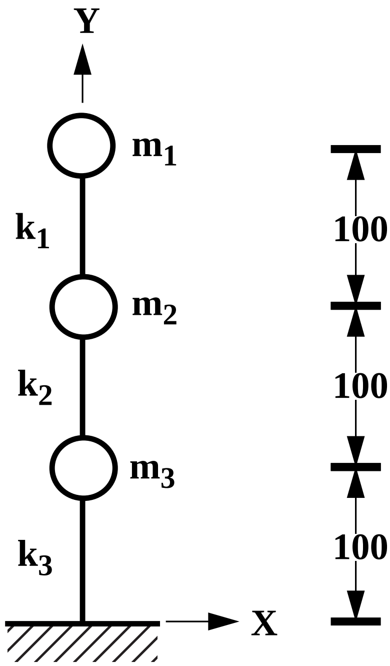


Objectives:

- Model a simple lumped mass system using beam elements and point elements.
- Apply the proper constraints to the model to ensure stability during analysis.
- Calculate the first two modes of vibration for the system.

Model Description:

Simple Lumped Mass System



Remember: for a beam, $k = \frac{12EI}{L^3}$

This system can be modeled using bar elements and concentrated masses.

In order to idealize the above lumped mass system, the following assumptions are made:

1) L1 = L2 = L3 = 100
2) E = 10.0E6

Thus, $I_1 = \frac{k_1 L^3}{12E}$, etc.

Purpose of Exercise:

Calculate the first two modes , where:

$m_1 = 1.0 \frac{lb}{in}s^2$ $k_1 = 600.0 \frac{lb}{in}$

$m_2 = 1.5 \frac{lb}{in}s^2$ $k_2 = 1200.0 \frac{lb}{in}$

$m_3 = 2.0 \frac{lb}{in}s^2$ $k_3 = 1800.0 \frac{lb}{in}$

Clough and Penzian:

$$\omega_1 = 14.5 \frac{rad}{sec} \phi_1 = \begin{Bmatrix} 1.0 \\ 0.646 \\ 0.301 \end{Bmatrix}$$

This example problem introduces normal modes analysis of a simple lumped mass system, represented by a beam with masses applied. SOL 103 is used for this analysis.

Suggested Exercise Steps:

- Open a new database.
- Create a curve and mesh it with bar elements (CBAR). Use the meshing feature so that elements and nodes (GRID) will be generated automatically by MSC/PATRAN.
- Create 3 point elements (using Finte...: Create: Element: Edit). These point elements will be needed for CONM2 assignment.
- Define material (MAT1) and element properties (PBAR). Be certain to include assumed values for Elastic Modulus and Inertia 1,1.
- Apply a fixed boundary constraint (SPC1) at one end of the beam.
- Constrain two translational D.O.F.'s (Y and Z) and three rotational D.O.F.'s at the other 3 points.
- Use the load and boundary sets to define a loadcase.
- Prepare the model for a Normal Modes analysis (SOL 103 & PARAMs).
- Generate and submit input file to the MSC/NASTRAN solver.
- Compare the result with theory.

Results:

SUBCASE 1

R E A L   E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIANS	CYCLES	GENERALIZED	GENERALIZED
1	1	2.108789E+02	1.452167E+01	2.311195E+00		
2	2	9.639604E+02	3.104771E+01	4.941397E+00		
3	3	2.125159E+03	4.609945E+01	7.336955E+00		

Sample NASTRAN Input File:

```
ID SEMINAR, Appendix F
SOL 103
TIME 60
CEND
SEALL = ALL
SUPER = ALL
TITLE = Simple Lumped Mass System
ECHO = SORT
MAXLINES = 999999999
SPC = 2
SUBCASE 1
SUBTITLE=sub_1
   METHOD = 1
   VECTOR(SORT1,REAL)=ALL
   SPCFORCES(SORT1,REAL)=ALL
BEGIN BULK
PARAM    POST    -1
PARAM    PATVER  3.
PARAM    AUTOSPC YES
PARAM   COUPMASS 1
PARAM    K6ROT   0.
PARAM    WTMASS  1.
PARAM,NOCOMPS,-1
EIGRL    1                       3       0
PBAR     1       1       0.      50.
CBAR     1       1       1       2       1.      0.      0.
PBAR     2       1       0.      100.
CBAR     2       2       2       3       1.      0.      0.
PBAR     3       1       0.      150.
CBAR     3       3       3       4       1.      0.      0.
CONM2    4       1               1.
CONM2    5       2               1.5
CONM2    6       3               2.
MAT1     1       1.+6
GRID     1               0.      300.    0.
GRID     2               0.      200.    0.
GRID     3               0.      99.9999 0.
GRID     4               0.      0.      0.
SPCADD   2       1       3
SPC1     1       123456  4
SPC1     3       23456   1       2       3
ENDDATA
```