

Mechanics of materials Computer Project Instruction Fall, 2013

Coding Language: *your favorite ones*, e.g., matlab, c/c++, fortran, python, ...

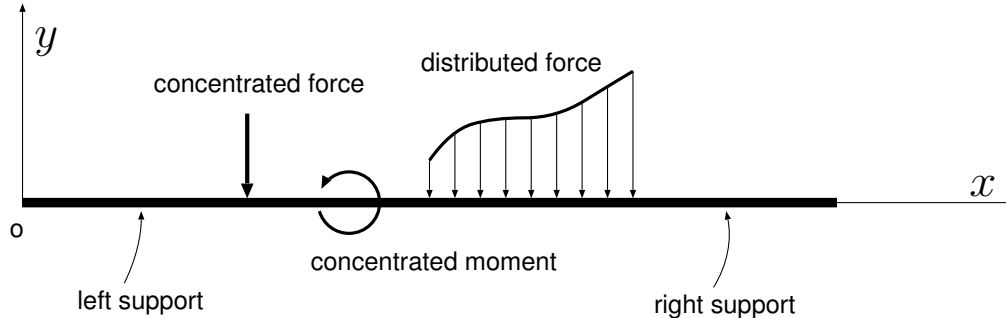
[Guideline starts here]

On a beam with two supports (see the figure below), external loads are confined to three types: 1. concentrated force; 2. concentrated bending moment; and 3. distributed force.

The two supports are in four types: 1. pin support; 2. roller support; 3. fixed support; or 4. void, provided that the beam is in stable configuration.

Please compose a computer program to solve for the following quantities of the beam: 1. the shear force $V(x)$; 2. the bending moment $M(x)$; 3. the deflection $v(x)$, and 4. deflection angle $\theta(x)$.

Note the code is intended to be general-purpose, the locations of the left and right supports, as well as the number and locations of loads hence should all be treated as indefinite.



units system: SI, **length:** m, **moment:** $\text{N} \cdot \text{m}$, **force:** N, **intensity q :** N/m
sign conventions for loads: **forces:** downward as positive; **moments:** counter-clockwise as positive

Function Interface (using MATLAB for demonstration):

```
function [x,V,M,vy,theta]=beamsolver(L,EI,supports,loads)
```

detailed descriptions of I/O parameters

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INPUTS:

symbol	physical quantity	MATLAB data type	Example
L	the total length of the beam	real	10.0
EI	flexural rigidity	real	2e8
supports	the two supports	2-element cell	{{'p',1.0},{ 'r',8.0}}
loads	the external loads	cell	(see next page)

OUTPUTS:

symbol	physical quantity	MATLAB data type	Example
x	piecewise position for segments boundaries should be overlapped	1D row vector	[(0:0.1:1),(1:0.1:10)] note 1 is overlapped
V	shear force $V(x)$	1D row vector	
M	bending moment $M(x)$	1D row vector	
vy	deflection $v(x)$	1D row vector	
theta	deflection angle $\theta(x)$	1D row vector	

for 'supports', the form is in

{{support type, location}, {support type, location}}

where 'support type' can be any of 'p', 'r', 'f', 'v', corresponding to 'pin', 'roller', 'fixed' and 'void', respectively. The 'location' (in MATLAB, type real) is the x position of the support. For 'v' type, no 'location' is required.

The 'loads' has a cell structure with arbitrary number of entries as follows:

{{load type, specifier}, {load type, specifier}, ...}

Here the 'load type' can be any of 'f', 'm', 'd'. Furthermore,

if load type == 'f' (concentrated force)

specifier = [location, value] (2-element vector in real)

if load type == 'm' (concentrated moment)

specifier = [location, value] (2-element vector in real)

if load type == 'd' (distributed force)

a. specifier = [xs, xe, xc, k0, [k1, [k2, [k3...]]]]

or

b. specifier = [x;q] (a $2 \times N$ array in real)

for option (a), squared bracket after k_0 means $[k_1, [k_2, [k_3 \dots]]]$ are optional. This also applies for $[k_2, [k_3 \dots]]$, etc. Option (a) means a polynomial for $q(x)$
 $q(x) = k_0 + k_1(x - x_c) + k_2(x - x_c)^2 + k_3(x - x_c)^3 + \dots$ where $x \in [x_s, x_e]$

Note #1: for constant $q(x)$, x_c can be arbitrary.

Note #2: number of segments N of x should be determined by the code itself in a reasonable manner.

Examples for 'loads':

```
{...
{'f',[2.0, 9000]}, ... % a concentrated force of 9000 N at x=2.0 m
{'f',
[7.0, 15000]}, ... % another concentrated force of 15000 N at x=7.0 m
{'m',
[5.0, -4000]}, ... % another concentrated moment of -4000 N at x=5.0 m
{'d',[2.0,
4.0, 2.0, 100]}, ... % a distributed force on (2.0, 4.0) with q=100
{'d',[7.0,
9.0, 3.0, 20, 100]}, ... % a distributed force on (7.0, 9.0) with q=20+100(x-3)
{'d',[(10.0:0.01:13.0); (0:0.01:3.0).^2]} ...
% a distributed force on (10.0, 13.0)
}
```

Code submission:

<http://am.hit.edu.cn/momproj/login.html>

plus a short description page containing

- an running example with output figures of $V(x)$, $M(x)$ and $\theta(x)$
- names/IDs/contact info of group members and word load for each student.