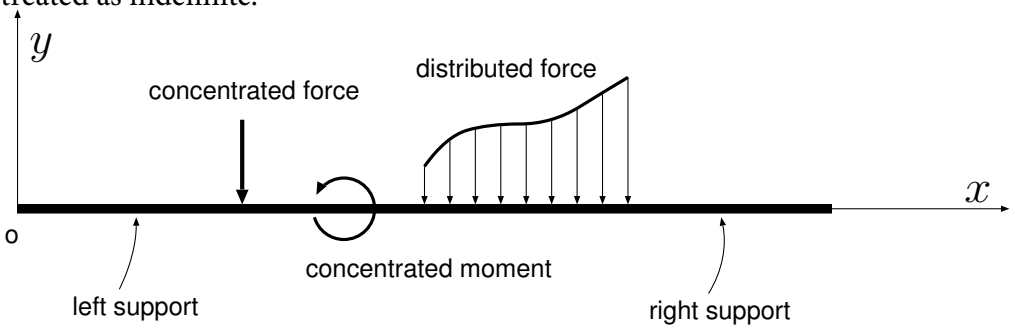
Mechanics of materials
Computer Project Instruction
Fall, 2012

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 in MATLAB scripting language to solve for the following three quantities of the beam:
1. the shear force V; 2. the bending moment M; and 3. the deflection v.

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**: $\mathrm{N}\cdot\mathrm{m}$, **force**: N, **intensity** q: $\mathrm{N/m}$
sign conventions for loads: **forces**: downward as positive; **moments**: counter-clockwise as positive

The final matlab code should have a common interface, as stated below.

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

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)
`maxdx`	the maximum x-spacing dx	real	0.1

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 k0 means [k1, [k2, [k3...]]] are optional. This also applies for [k2, [k3...]], etc. Option (a) means a polynomial for $q(x)$

$q(x)$ =k0+k1*(x-xc)+k2*(x-xc)^2+k3*(x-xc)^3 +... where $x \in$[xs,xe]

Note: for constant $q(x)$, xc can be arbitrary.

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)
}
```

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	1D row vector	
`M`	bending moment	1D row vector	
`vy`	deflection	1D row vector	