

**Quick Questions**

For each of the MATLAB snippets in problems 1 through 5, manually determine the values of the variables *at the end* of each pass through the loop.

You can use MATLAB to check your results, but you must be able to complete the tables by hand. For example, this type of question may be used on an exam when you do not have access to MATLAB. More importantly, being able to step through code is an essential debugging skill.

**Example:**

```
n = 4;
f = 1;
for i=2:n
    f = f*i;
end
```

n	i	f	Comment
4	undefined	1	Before loop
4	2	2	
4	3	6	
4	4	24	
4	4	24	After loop

**Problems:**

## 1. (5 points)

```
for j=2:8
    y = j/2;
end
```

j	y	Comment
undefined	0	before loop
		After loop

## 2. (5 points)

```
t = 0;
for k=1:5
    s = k-5;
    t = t + 2*s+1;
end
```

k	s	t	Comment
undefined	undefined	0	before loop
			After loop

## 3. (5 points)

```

v = 0;
for k=5:1
    if k < 2.5
        v = 2*k - 2;
    else
        v = sqrt(k);
    end
end
end

```

k	v	Comment
		Before loop
		After loop

## 4. (5 points)

```

v = 0;
for k=5:-1:-1
    if k < 2.5
        v = 2*k - 2;
    else
        v = sqrt(k);
    end
end
end

```

k	v	Comment
		Before loop
		After loop

## 5. (5 points)

```

x = 25;
tol = 5e-3;
for i=1:25
    if x < tol
        break
    end
    x = x/4;
end
end

```

i	x	Comment
		Before loop
		After loop

## Comprehensive Questions

6. (10 points) Write a function m-file that returns the appropriate rate for a first class postage via US Mail. The input to the function is the weight of the item to be mailed. The output of the function is the cost in cents. Be careful in reading the postage rate table so that your program computes the correct postage. *Hint: www.usps.com.*

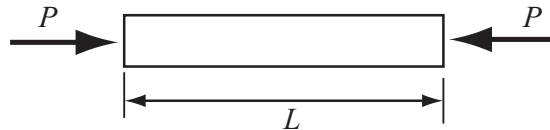
In addition to returning the correct postage (of course), your function should provide an error message for negative weights and weights in excess of 13 ounces (the maximum). *Hint: Use the built-in error function.*

Test your function with the following statements (which assume your function is called "postage").

```
>> postage(0.75)
>> postage(1.25)
>> postage(12.999999)
>> postage(13.000001)
```

7. (25 points)

The sketch depicts a beam with an axial load  $P$ . The geometry of the beam determines its cross sectional area  $A$ , momentum of inertia  $I$ , and radius of gyration  $k = \sqrt{I/A}$ . Figure 1 shows the geometrical parameters of a beam with a circular cross section.



When  $P$  exceeds a critical value,  $P_{cr}$ , the beam buckles. The value of  $P_{cr}$  depends on the material properties of the beam, the geometric properties of the beam cross section, and the end conditions (boundary constraints) on the beam. Figure 2 shows the four basic boundary conditions for beams under axial compressive load  $P$ .

The geometric relationship between the beam length and its cross section is indicated by the slenderness ratio

$$S_r = \frac{L_{\text{eff}}}{k} \quad (1)$$

where the  $L_{\text{eff}}$  is determined by  $L$ , the physical length, and the boundary conditions. The formula for predicting  $P_{cr}$  depends on  $S_r$  and the line of action of the applied force. If the load  $P$  is applied through the centroid of the beam cross section

$$S_r > \pi \sqrt{\frac{2E}{S_y}} : \quad P_{cr} = \frac{\pi^2 AE}{S_r^2} \quad (2)$$

$$S_r \leq \pi \sqrt{\frac{2E}{S_y}} : \quad P_{cr} = A \left[ S_y - \frac{1}{E} \left( \frac{S_y S_r}{2\pi} \right)^2 \right] \quad (3)$$

where  $E$  is the modulus of elasticity of the material,  $S_y$  is the yield stress, and  $A$  is the cross sectional area of the beam.

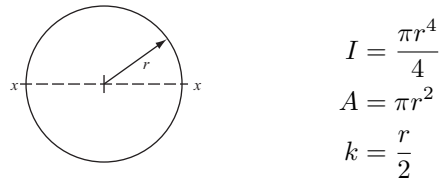


Figure 1: Geometrical properties of a cylindrical beam

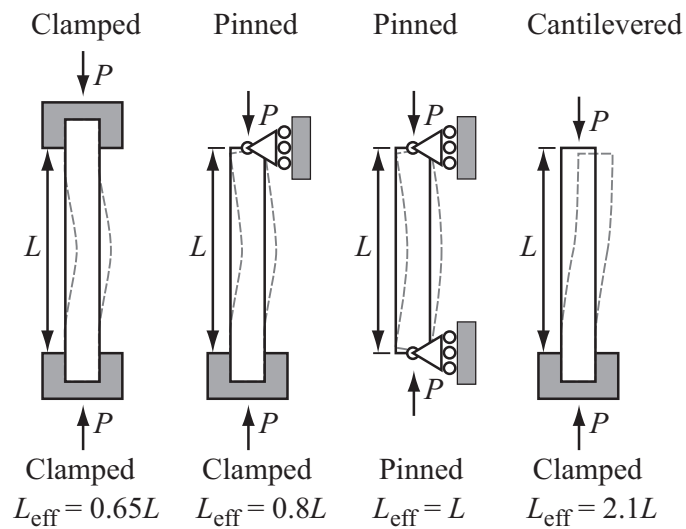


Figure 2: Standard boundary conditions and effective lengths for beams under compressive axial loads.

**Problems:**

- Write a MATLAB function to evaluate  $P_{\text{cr}}$  for any  $A$ ,  $E$ ,  $I$ ,  $L_{\text{eff}}$ , and  $S_y$  values.
- Use the function from Exercise 7a to plot  $P_{\text{cr}}$  as a function of  $L$  for a clamped-pin beam with a circular cross section having the dimensions  $r = 6$  cm. Use the material properties of 2024-T6 Aluminum and  $r \leq L \leq 40r$ .