TEXTBOOK TESTBANKS

Solutions Manual for Engineering Computation 2nd Musto

SOLUTIONS MANUAL SAMPLE PREVIEW

PUBLISHER

McGraw-Hill

COPYRIGHT

2021

RESOURCE TYPE

Solutions Manual

ISBN

9780073380278

Problem 1.1

Describe the differences between analytic and algorithmic solutions.

Answer:

An *analytic solution* is an exact solution, based on the application of the mathematical principles of algebra, calculus, etc.

An *algorithmic solution* is an approximate solution, based on the application of a computational procedure. The algorithm will generally rely on principles of arithmetic only to solve the problem; therefore, while the solution is approximate, it also eliminates the need to apply more complicated mathematics to the problem.

Develop the pseudocode for an algorithmic solution for finding the two points where the function $f(x) = 3x^2 - 12.4x + 3$ crosses the x-axis.

Answer:

1. Define an initial value for x; e.g. $x_l = 0$.
2. Calculate the value of $f(x)$ at x_l, $f(x_l)$
3. Add a small increment to x_l to get x_r; e.g. $x_r = x_l + .01$
4. Calculate the value of $f(x)$ at x_r, $f(x_r)$
5. If $f(x_l)$ and $f(x_r)$ have the same sign, then make $x_l = x_r$. Go to Step 2 and repeat. If $f(x_l)$ and $f(x_r)$ have different signs, then calculate the first axis crossing to be at $x_1 = \frac{x_l + x_r}{2}$ and continue.
6. Define $x_l = x_r$.
7. Calculate the value of $f(x)$ at x_l, $f(x_l)$
8. Add a small increment to x_l to get x_r; e.g. $x_r = x_l + .01$
9. Calculate the value of $f(x)$ at x_r, $f(x_r)$
10. If $f(x_l)$ and $f(x_r)$ have the same sign, then make $x_l = x_r$. Go to Step 7 and repeat. If $f(x_l)$ and $f(x_r)$ have different signs, then calculate the second axis crossing to be at $x_2 = \frac{x_l + x_r}{2}$.
11. End the algorithm, and report the results x_1 and x_2.

Problem 1.3

Consider the cannon model developed in Section 1.1.1.

a) Using the equations developed and a launch speed of 10.0 m/s, develop the pseudocode for an algorithmic solution to determine the launch angle required to reach a peak height of at least 2.5 meters.
b) Using discrete values spaced 5° apart, carry out the algorithmic solution by hand. Report each step in the algorithm in a table.
c) Perform an analytic solution for this problem, and compare the result with your algorithmic solution.

Solution:

a) In this algorithm, intervals of $\Delta t = 0.5$ s and $\Delta\theta = 5°$and will be used.

1. Define the variable $\theta = 5°$.
2. Define the variable $h_{peak} = 0$ m.
3. Define the variable $t = 0$ s.
4. Calculate $h = (10$
5. Define the variable $t_{new} = t +$
6. Calculate $h_{new} = (10\,\frac{\mathrm{m}}{\mathrm{s}})t_{new}\sin\theta - \frac{1}{2}(9.81\,\frac{m}{s^2})t_{new}{}^2$
7. If $h > h_{peak}$, then make $h_{peak} = h$.
8. If $h < h_{new}$, set $t = t_{new}$, $h = h_{new}$, and return to Step 4.
9. If $h_{peak} \leq 2.5$ m, then make $\theta = \theta + 5°$, and return to Step 3.
10. Report the value for θ, and end the algorithm.

b) Carrying out the algorithm yields:

θ	t (s)	t_{new} (s)	h (m)	h_{new} (m)	h_{peak} (m)
5°	0.0	0.5	0.0	-0.8	0.0
10°	0.0	0.5	0.0	-0.4	0.0
15°	0.0	0.5	0.0	0.1	0.0
15°	0.5	1.0	0.1	-2.3	0.1
20°	0.0	0.5	0.0	0.5	0.1
20°	0.5	1.0	0.5	-1.5	0.5
25°	0.0	0.5	0.0	0.9	0.5
25°	0.5	1.0	0.9	-0.7	0.9
30°	0.0	0.5	0.0	1.3	0.9
30°	0.5	1.0	1.3	0.1	1.3
35°	0.0	0.5	0.0	1.6	1.3
35°	0.5	1.0	1.6	0.8	1.6
40°	0.0	0.5	0.0	2.0	1.6
40°	0.5	1.0	2.0	1.5	2.0

45°	0.0	0.5	0.0	2.3	2.0
45°	0.5	1.0	2.3	2.2	2.3
50°	0.0	0.5	0.0	2.6	2.3
50°	0.5	1.0	2.6	2.8	2.6
50°	1.0	1.5	2.8	0.5	2.8

Answer: A launch angle of 50° will yield a peak height greater than 2.5 m.

c) The analytic solution is as follows:

From Eq. 1.4, the height will be maximum at:

$$t = \frac{v\sin\theta}{g}$$

Substituting this into Eq. 1.1, with the height set at 2.5 m, yields:

$$2.5\ \text{m} = \boxed{\quad 1 \quad g \quad g \quad}$$

With $v = 10.0$ m/s and $g = 9.81$ m/s^2, this can be solved for θ analytically:

$$\sin^2\theta = .4905$$

or:

$$\theta = 44.5°$$

Answer: A launch angle of 44.5° yields a peak height of 2.5 m.

Discussion: While both the algorithmic and the analytic solution produced answers that yielded a peak height of *at least* 2.5 m, the discrete nature of the algorithmic solution missed the smallest launch angle that would achieve this goal. Using the 50° launch angle given by the algorithmic solution, the peak height would actually be 3.0 m.

Consider the cannonball problem described in Section 1.1.1. You have been asked to determine a combination of launch speed and angle required to clear a 5-meter wall erected 8 meters from the launch point. Develop the pseudocode for an algorithmic solution to this problem.

Answer: This algorithm assumes that some maximum speed of the cannon, v_{max}, is known, and that there is a solution to the problem. Also, a very small time step would be recommended.

1. Define the variables $\theta = \theta_{init}$ and $v = v_{init}$ (some practical arbitrary starting values).
2. Define the variable $t = 0$ s.
3. Calculate $x = vt\cos\theta$
4. If $x < 8$ m, then increase $t = t + \Delta t$ and repeat Step 3.
5. Calculate $h = vt\sin\theta - \frac{1}{2}(9.81\frac{m}{s^2})t^2$
6. If $h < 5$ m and $v < v_{max}$, then increase $v = v + \Delta v$ and return to Step 2.
7. If $h < 5$ m and $v \geq v_{max}$, then set $v = v_{max}$, increase $\theta = \theta + \Delta\theta$, and return to Step 2.
8. Report the values for v and θ, and end the algorithm.

Problem 1.6

Develop and write the pseudocode for an algorithm that can take a list of 10 integers and determine how many are even numbers.

Answer:

1) Define two “counters” to be set at zero; e.g. $c = 0$ and $d = 0$.
2) Read the first number in the list; call it x.
3) Divide the number by two; e.g. $y = \frac{x}{2}$
4) Round off the number y; call the rounded number z.
5) If $y = z$, then the number is even, and the counters c and d are increased by 1. If $y \neq z$, then the number is odd, and only the counter d is increased by 1.
6) If $d < 10$, read the element is position $d + 1$ from the list, call it x, and go to Step 3.
7) End the algorithm, and report the counter value c as the number of even elements in the list.

Problem 1.6

An engineer measures the diameters and lengths of a number of steel rods. Calculate the cross-sectional area and total volume of each of the rods, and report the answer using the correct number of significant digits.

Rod	*Diameter*	*Length*
A	0.125 in	12.80 in
B	0.13 in	1.1 ft
C	0.1250 in	1.1 ft
D	.01250 in	1.067 ft
E	0.38 in	8.11 in
F	0.3750 in	8.110 in
G	0.3750 in	8.1 in
H	1.2 in	5.29 in
I	1.20 in	5.290 in
J	1.200 in	5.3 in

Solution:

Rod A: The diameter has 3 significant digits, the length has 4.

Cross Sectional Area: $A = \pi\left(\frac{0.125\text{in}}{2}\right)^2 = \pi(0.0625\text{in})^2$
$= \pi(0.00391\text{in}^2) = 0.0123\text{in}^2$

Volume: $V = A(12.80\text{in}) = (0.0123\text{in}^2)(12.80\text{in})$
$= 0.157\text{in}^3$

Rod B: The diameter has 2 significant digits, the length has 2.

Cross Sectional Area: $A = \pi\left(\frac{0.13\text{in}}{2}\right)^2 = \pi(0.065\text{in})^2$
$= \pi(0.0042\text{in}^2) = 0.013\text{in}^2$

Volume: $V = A(1.1\text{ft})(\frac{12\text{in}}{\text{ft}}) = (0.013\text{in}^2)(13\text{in})$
$= 0.17\text{in}^3$

Rod C: The diameter has 4 significant digits, the length has 2.

$$A = \pi\left(\frac{0.1250\text{in}}{2}\right)^2 = \pi(0.0625\text{in})^2$$
$$= \pi(0.0039\text{in}^2) = 0.012\text{in}^2$$

Volume: $V = A(1.1\text{ft})(\frac{12\text{in}}{\text{ft}}) = (0.012\text{in}^2)(13\text{in})$
$= 0.16\text{in}^3$

Rod D: The diameter has 4 significant digits, the length has 4.

Cross Sectional Area: $=$
$= 0.01227\text{in}^2$

Volume: $V = A(1.067\text{ft})(\frac{12\text{in}}{\text{ft}}) = (0.01227\text{in}^2)(12.80\text{in})$
$= 0.1571\text{in}^3$

Rod E: The diameter has 2 significant digits, the length has 3.

Cross Sectional Area: $= \pi(0.19\text{in})^2$
$= \pi(0.036\text{in}^2)$

Volume: $V = A(8.11\text{in}) = (0.11\text{in}^2)(8.11\text{in})$
$= 0.89\text{in}^3$

Rod F: The diameter has 4 significant digits, the length has 4.

Cross Sectional Area: $= \pi(0.1875\text{in})^2$
$= 0.1105\text{in}^2$

Volume: $V = A(8.110\text{in}) = (0.1105\text{in}^2)(8.110\text{in})$
$= 0.8962\text{in}^3$

Rod G: The diameter has 4 significant digits, the length has 2.

Cross Sectional Area: $= \pi(0.1875\text{in})^2$
$= 0.1105\text{in}^2$

Volume: $V = A(8.1\text{in}) = (0.1105\text{in}^2)(8.1\text{in})$
$= 0.90\text{in}^3$

Rod H: The diameter has 2 significant digits, the length has 3.

Cross Sectional Area: $A = \pi\left(\frac{1.2\text{in}}{2}\right)^2 = \pi(0.60\text{in})^2$
$= \pi(0.36\text{in}^2) = 1.1\text{in}^2$

Volume: $V = A(5.29\text{in}) = (1.1\text{in}^2)(5.29\text{in})$
$= 5.8\text{in}^3$

Rod I: The diameter has 3 significant digits, the length has 4.

Cross Sectional Area: $= \pi(0.600\text{in})^2$
$= \pi(0.360\text{in}^2)$

Volume: $V = A(5.290\text{in}) = (1.13\text{in}^2)(5.290\text{in})$
$= 5.98\text{in}^3$

Rod J: The diameter has 4 significant digits, the length has 2.

Cross Sectional Area: $A = \pi\left(\frac{1.200\text{in}}{2}\right)^2 = \pi(0.6000\text{in})^2$
$= \pi(0.3600\text{in}^2) = 1.131\text{in}^2$

Volume: $V = A(5.3\text{in}) = (1.131\text{in}^2)(5.3\text{in})$
$= 6.0\text{in}^3$

Rod	***Diameter***	***Length***	***Area (in^2)***	***Volume (in^3)***
A	0.125 in	12.80 in	0.0123	0.157
B	0.13 in	1.1 ft	0.013	0.17
C	0.1250 in	1.1 ft	0.012	0.16
D	.01250 in	1.067 ft	0.01227	0.1571
E	0.38 in	8.11 in	0.11	0.89
F	0.3750 in	8.110 in	.1105	0.8962
G	0.3750 in	8.1 in	.1105	0.90
H	1.2 in	5.29 in	1.1	5.8
I	1.20 in	5.290 in	1.13	5.98
J	1.200 in	5.3 in	1.131	6.0

Problem 1.7

Using your computer, research and document a value for the density of steel. Use the value to determine the weight of each rod described in Problem 1.6, reporting each answer using the correct number of significant digits.

Answer: Using a typical value of 0.283lb/in^3 for the weight density of steel:

Rod	*Diameter*	*Length*	*Area (in^2)*	*Volume (in^3)*	*Weight (lb)*
A	0.125 in	12.80 in	0.0123	0.157	0.0444
B	0.13 in	1.1 ft	0.013	0.17	0.048
C	0.1250 in	1.1 ft	0.012	0.16	0.045
D	.01250 in	1.067 ft	0.01227	0.1571	0.0445
E	0.38 in	8.11 in	0.11	0.89	0.25
F	0.3750 in	8.110 in	.1105	0.8962	0.254
G	0.3750 in	8.1 in	.1105	0.90	0.25
H	1.2 in	5.29 in	1.1	5.8	1.6
I	1.20 in	5.290 in	1.13	5.98	1.69
J	1.200 in	5.3 in	1.131	6.0	1.7