KATHERINE Smith

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ENCE 3300
COMPUTATIONAL METHODS IN CIVIL ENGINEERING

11/26/07

TEST 4

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1. Find the least-squares line approximation to the data listed.
   Also find: the standard error of the estimate; the cofficient of determination; and the
   correlation coefficient.

	X	Y	X·Y	X^2	S_R
	2	102.6	213.2	4	.3136
	4	107.0	428	16	3.5721
	6	108.4	650.4	36	0.0484
	8	110.0	880	64	1.5625
	10	114.0	1140	100	.1024
	12	117.6	1411.2	144	.0441
	14	120.2	1682.8	196	.0676
	16	125.0	2000	256	2.1609
	18	126.0	2268	324	.36
	20	131.2	2624	400	2.3409
	22	132.2	2908.4	484	.2916
Σ	132	1294.2	16,206	2024	10.8641

$\bar{x} = 12$ $\bar{y} = 117.7$

$$a_1 = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2} = \frac{(11)(16{,}206) - (132)(1294.2)}{(11)(2024) - (132)^2} = \frac{7431.6}{4840} = 1.535$$

$$a_0 = \bar{y} - (a_1)(\bar{x}) = 117.4 - (1.535)(12) = 98.97$$

Line Approx. 99.45

$y = 1.535x + 98.97$ -2

Standard error of estimate: $S_{y/x} = \sqrt{\frac{S_R}{n-2}} = \sqrt{\frac{10.8641}{9}} = \sqrt{1.207} = 1.098$ $S_{y/x} =$ 1.05 OK

Coefficent of Determination: $R^2 = \frac{S_t - S_R}{S_t} = \frac{1022.91 - 10.8641}{1022.91} = 0.9894$ $R^2 =$ ✓

Correlation coefficent: $0.9947 = R$ ✓

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2. What transform must be used on the equations below to allow the use of linear least squares?

a. $y = ae^{bx}$

$\ln y = \ln a + bx$ ✓

b. $y = ax^b$

$\ln y = \ln a + b \ln x$ ✓

c. $y = ax/(b + x)$

$\frac{1}{y} = \frac{b}{a}\left(\frac{1}{x}\right) + \frac{1}{a}$ ✓

3. For the falling parachutist problem, Example problem 1.2, assume that the first jumper has a mass of 68.1 kg and a drag coefficient of 12.5 kg/s. If a second jumper has a mass of 75 kg and a drag coefficient of 14 kg/s, how long will it take the second jumper to attain the same velocity reached by the first jumper in 10 s?

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velocity of jumper 1 @ 10s = 44.87 m/s

$$v(t) = \frac{g \cdot m}{c}\left(1 - e^{\left(\frac{-c}{m}\right)t}\right)$$

$$44.87 = \frac{(9.81)(75\text{ kg})}{(14)}\left(1 - e^{\left(14/75\right)t}\right)$$

$$0.8538 = 1 - e^{(-14/75)t}$$

$$0.1462 = e^{(-14/75)t}$$

$$\ln 0.1462 = (-14/75)t$$

$$t = 10.3 \text{ secs}$$

✓

4. A terrorist decides to poison all the people in an airtight building by pumping a mixture of gas that contains 10% toxic gas into the 100,000 ft^3 building (which holds 6000 lb_m of air initially) at a rate of 6 lb_m/min. When the concentration of the toxic gas reaches 4%, people will start to die. The terrorist assumes that the mass of gas in the building will remain constant and calculated how long it will take to kill the people. You realize that the building is airtight and that the mass of gas in the building will increase with time. Will it take more or less time than the terrorist originally calculated to accumulate a toxic level of gas into the building? (Make sure you do both the terrorist's calculation and the corrected calculation.)

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Terrorist:

$Q_{in} = Q_{out}$

poison — air

$$\frac{Q_{in_p} \Delta t}{M} = 4\%$$

$$\frac{6 \text{ lb/min}(t)}{6000} = 4\%$$

$$\frac{6}{6000}(t) = 0.04$$

$t = 40$ min — terrorists Calculation

Corrected:

$$\frac{Q \Delta T}{Q \Delta T + M} = 4\%$$

solve ΔT

$$\frac{6 \text{ lb/min}(t)}{6 \text{ lb/min}(t) + 6000 \text{ lb}_m} = 4\%$$

$6t = 0.04(6t + 6000)$

$6t = .24t + 240$

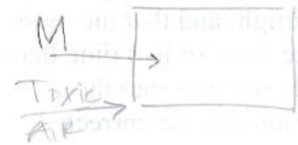
$5.76t = 240$

$t = 41.667$ min — corrected calculation

It will take more time than what the terrorist originally calculated.

inflow = 10% gas — −10

Airtight



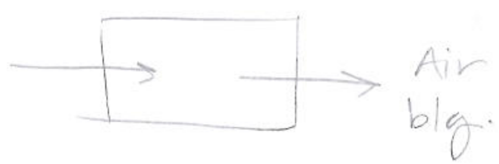
Inflow
10%

$$\frac{10\% \left(6\ \text{lb}/\text{m}\right)(t)}{M_T} = 4\%$$

$M_T = M_{\text{air, blg}} + M_{\text{Air, gas}}$

$M_{\text{Air, gas}} = \frac{6\ (\text{lb})}{\text{min}}(t)$

Constant



$$\frac{(10\%)(6\ \text{lb})(t)}{M_{\text{blg}}} = 4\%$$