Holistic Numerical Methods Institute
committed to bringing numerical methods to undergraduates

Multiple-Choice Test
Nonlinear Regression
Regression

1. When using the linearized data model to find the constants of the regression model $y = ae^{bx}$ to best fit $(x_1, y_1), (x_2, y_2), \ldots\ldots\ldots (x_n, y_n)$, the sum is the square of the residuals that is minimized is

(A) $\sum_{i=1}^{n}\left(y_i - ae^{bx_i}\right)^2$

(B) $\sum_{i=1}^{n}\left(\ln(y_i) - \ln a - bx_i\right)^2$

(C) $\sum_{i=1}^{n}\left(y_i - \ln a - bx_i\right)^2$

(D) $\sum_{i=1}^{n}\left(\ln(y_i) - \ln a - b\ln(x_i)\right)^2$

2. It is suspected from theoretical considerations that the rate of flow from a firehouse is proportional to some power of the nozzle pressure. Assume pressure data is more accurate. You are linearizing the data.

Flow rate, F (gallons/min)	96	129	135	145	168	235
Pressure, p (psi)	11	17	20	25	40	55

The exponent of the power of the nozzle pressure in the regression model, $F = ap^b$ most nearly is

(A) 0.497
(B) 0.556
(C) 0.578
(D) 0.678

3. The linearized data model for the stress-strain curve $\sigma = K_1 \varepsilon e^{-K_2 \varepsilon}$ for concrete in compression, where σ is the stress and ε is the strain is

(A) $\ln \sigma = \ln k_1 + \ln \varepsilon - k_2 \varepsilon$

(B) $\ln \dfrac{\sigma}{\varepsilon} = \ln k_1 - k_2 \varepsilon$

(C) $\ln \dfrac{\sigma}{\varepsilon} = \ln k_1 + k_2 \varepsilon$

(D) $\ln \sigma = \ln(k_1 \varepsilon) - k_2 \varepsilon$

4. In nonlinear regression, finding the constants of the model requires solution of simultaneous nonlinear equations. However in the exponential model, $y = ae^{bx}$ that is best fit to $(x_1, y_1), (x_2, y_2), \ldots\ldots.(x_n, y_n)$, the value of b can be found as a solution of a sample nonlinear equation. That equation is given by

(A) $\sum_{i=1}^{n} y_i x_i e^{bx_i} - \sum_{i=1}^{n} y_i e^{bx_i} \sum_{i=1}^{n} x_i = 0$

(B) $\sum_{i=1}^{n} y_i x_i e^{bx_i} - \dfrac{\sum_{i=1}^{n} y_i e^{bx_i}}{\sum_{i=1}^{n} e^{2bx_i}} \sum_{i=1}^{n} x_i e^{2bx_i} = 0$

(C) $\sum_{i=1}^{n} y_i x_i e^{bx_i} - \dfrac{\sum_{i=1}^{n} y_i e^{bx_i}}{\sum_{i=1}^{n} e^{2bx_i}} \sum_{i=1}^{n} e^{bx_i} = 0$

(D) $\sum_{i=1}^{n} y_i e^{bx_i} - \dfrac{\sum_{i=1}^{n} y_i e^{bx_i}}{\sum_{i=1}^{n} e^{2bx_i}} \sum_{i=1}^{n} x_i e^{2bx_i} = 0$

5. There is a functional relationship between the mass density *p* of air and altitude *h* above the sea level

Altitude above sea level, h (km)	0.32	0.64	1.28	1.60
Mass Density, ρ (kg/m^3)	1.15	1.10	1.05	0.95

In the regression model $\rho = k_1 e^{\cdot k_2 h}$, the constant k_2 is found as $k_2 = 0.1315$. Assuming the mass density of air at the top of the atmosphere is $1/1000^{th}$ of the mass density of air at sea level. The altitude in *km* of the top of the atmosphere most nearly is

(A) 46.2
(B) 46.6
(C) 49.7
(D) 52.5

6. A steel cylinder at 80^{o}F of length 12" is placed in a liquid nitrogen bath $(-315^o F)$. If thermal expansion coefficient of steel behaves as a second order polynomial of temperature and the polynomial is found by regressing the data below,

Temperature (^{o}F)	Thermal expansion coefficient (μ in/in/^{o}F)
-320	2.76
-240	3.83
-160	4.72
-80	5.43
0	6.00
80	6.47

the reduction in the length of cylinder most nearly is

(A) 0.0219"
(B) 0.0231"
(C) 0.0235"
(D) 0.0307"