1. Differentiate between the following models

   (a) Linear and non-linear models [2 marks]

   (b) Parametric and non-parametric models [2 marks]

2. For an exponential model $y = \gamma e^{\zeta x}$ that is best fit to the data $(x_1, y_1), \ldots, (x_n, y_n)$ derive a non-linear equation that can be used to estimate the value ζ. [5 marks]

3. Empirical results have shown that the rate of gas flow from a container is proportional to some power of the nozzle pressure. Below is given the flow rate, in cm^3 per second as a function of pressure.

Flow rate, F (cm^3/sec)	88	134	135	148	172	240
Pressure, P (psi)	15	22	26	28	52	60

   The rate of gas flow is related to the nozzle pressure via the regression model $F = \alpha e^{P\beta}$. By transforming the above data, find

   (a) The value of the regression parameters α and β [6 marks]

   (b) The rate of gas flow if the nozzle pressure is increased to 80 psi [2 marks]

4. The following data contains measurements of yield from an experiment done at six different temperature levels.

$\ln(F) = \ln(\alpha) + PB$

Temperature (T)	Yield (Y)
5	6.26
10	4.24
15	3.88
20	2.26
25	1.44
30	0.60

   If the Yield behaves as a second order polynomial function of temperature fit the above data to the model $Y = a_0 + a_1 T + a_2 T^2$

   [7 marks]

5. There exists a functional relationship between the mass density ρ of air and the altitude h above the sea level. A sample data of the two variables is given below

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

   The functional relationship can be expressed using the regression model $\rho = k_1 e^{-k_2 h}$, where the constant k_2 is found as $k_2 = 0.1315$. Assuming that the mass density of air at the top of the atmosphere is $1/1000^{\text{th}}$ of the mass density of air at sea level find the altitude in kilometers of the top of the atmosphere. [6 marks]

$$\begin{pmatrix} 6 & 105 & 2275 \\ 105 & 2275 & 55125 \\ 2275 & 55125 & 1421875 \end{pmatrix} \begin{pmatrix} a_0 \\ a_1 \\ a_2 \end{pmatrix} = \begin{pmatrix} 18.68 \\ 231.1 \\ 32175 \end{pmatrix}$$

$1.176 \times 10^{9} - 2.508185 \times 10^{9} + 1.5934375 \times 10^{9}$