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Course ENG 282
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An experiment is carried out by a Biomedical Engineer using a certain type of bacteria that doubles in population every 5hr in a growth medium. If the experiment is commenced with 20 bacteria

a) Develop a model for the system
b) Use the model to estimate the population of the bacteria in 1½ days
c) With the aid of Microsoft excel, Simulate the model and plot the variation of the Number of bacteria with time (t) for t = 0 to t = 15 hr using a step of 0.25hr
d) Making the initial number of bacteria to be 10, 30 and 50 successively. Plot the variations of the number of bacteria with time for t = 0 to t = 30hr using a step time of 0.5 hr on the same graph and
e) Comment on the results obtained in (d)

Soln

Since it is a growth model

$$\frac{dy}{dt} = Ky$$

$$\int \frac{dy}{y} = \int K dt$$

$$\ln y = Kt + C$$

$$y = e^{Kt} \cdot e^{C}$$

where $e^C = y_0$

$$y = y_0 e^{Kt}$$

At $t = 5$, $y_0 = 20$

where $Y = 2y_0$

$$2y_0 = y_0 e^{Kt}$$

At $t = 0$, $y_0 = 20$

$$y = 20 e^{K(0)}$$

$$y = 20$$

$= 2 \times 20 = 20e^{k(5)}$

$= 40 = 20e^{k(5)}$

$= \frac{40}{20} = e^{k(5)}$

$= 2 = e^{k(5)}$

$= k = \frac{\ln 2}{5} = 0.1386$

$k = 0.1386$

$= y = y_0 e^{0.1386t}$

2) where 1½ day is equivalent to;

1 day = 24 hrs

+ ½ day = 12 hrs

= 1½ day = 36 hrs

$y = 20e^{0.1386(36)}$

$y = 2937.5532$

$y = 2938$ bacteria

3) Where Y is the Variation of the Number of Bacteria in Microsoft Excel Solution

Y_1, Y_2 and Y_3 are the Initial number of bacter 10, 30 and 50 respectively in Microsoft Excel Solution.

Excuse me Sir, My laptop's Microsoft Excel works with Comma(,) instead of a decimal point when Simulating The Model.

$\frac{dy}{dt} = ky$ is the formular used in calculating exponential growth model

$y(t) = Ce^{kt} = y_0 e^{kt}$ is the general solution for exponential growth

$y = 2y_0 \Rightarrow$ for every 5 hrs

In this case $y \propto t$ where the Number of bacteria increases with increase in time

At time $t = 0$, Number of bacteria is $= 20$

At time $t = 5$, Number of bacteria $= 40$

It is estimated that there will 2938 bacteria in 1½ days if every 5hrs it doubleed exponentially

The results in (d) is an exponential growth because as time increases the Number of population (initial variations) increases as shown in the graph