Journal of Theory, Mathematics and Physics
Vol. 3, No. 09, 2024 ISSN: 2181-4376

PROJECT ON SOME REAL-LIFE APPLICATION OF EXPONENTIAL FUNCTION

Annotation: *Exponential function is pivotal mathematical concepts that play central roles in advanced mathematics. Unfortunately, these are also concepts that give students serious difficulties. In this project, we described and examined the application of exponential function on the following topics: - population of one-horned rhino, loudness of sound, radioactive decay, carbon dating and population of Muslims in the whole world as well as in some countries. This work is motivated by the work of [1-39].*

Keywords: *Exponential Function, Population, Sound, Decay, Carbon Dating, Muslim.*

Information about the authors

Anisha Akbar Ali
Department of Mathematics, MIT Campus, T.U., Janakpurdham, Nepal;

Suresh Kumar Sahani
Department of Science and Technology, Rajarshi Janak University, Janakpurdham, Nepal;

Kameshwar Sahani
Department of Civil Engineering, Kathmandu, Nepal;

Introduction:

An exponential function is a function in the form $f(x) = a(b^x) + c$, where a, b and c are not constant, and b is greater than 0 but not equal to 1. It is also known as a natural exponential function.

The first mathematician to use the value of constant e was Gottfried Leibniz and this was noted in letters between himself and Christiaan Huygens around 1690. At this time Leibniz referred to the constant as "b". It was not until the time frame around 1728 that the constant was given the name as we know today as e by Leonard Euler in work that he was doing around that time. Euler would go on to publish in 1748 that expression known well as:

$$e^{ix} = \cos x + i \sin x$$

Euler did so by way of series expansion of the trigonometric functions and the exponential functions.

Nowadays, exponential function is known as e. later in1697, Johann Bernoulli studied the calculus of the exponential function.

Definition:

Unlimited growth function:

The function modeled by the equation $f(t) = ae^{rt}$, where a and r are constants, is called unlimited growth function.

Unlimited decay function:

The function modeled by the equation $f(t) = ae^{-rt}$, where a and r are constants, is called unlimited decay function.

Limited growth function:

The function modeled by the equation $f(t) = M(1 - e^{-rt})$, where M and r are constants, is called limited growth function.

Logistic growth function:

The function modeled by the equation $f(t) = \frac{M}{1+ae^{-rMt}}$, where M, r and a are constants, is known as logistic growth function.

Discussion:

Problem1:

For past 4 years, the population of one-horned rhino in Nepal has been increasing at the rate of 16% per year. 4 years ago, it was found 256 one-horned rhinos in Nepal. Now, what is the population of them in present.

Problem2:

The population of a certain city in 2000 is 100000. The radioactive decay in population continuously at a rate of 3.5% per year, what will be its population in 2040.

Problem3:

By how much will the loudness of sound have increased if its intensity has doubled?

Problem4:

How long does it take for the substance to reduce to half of its original weight?

Problem5:

The current population of Muslims in 2024 in the world is 1.9 billion. The population is increasing by the tare of 2.2% very year then find the Muslims population in 2050.

Problem6: The population of Muslims in 2024 in Nepal, India, China, Japan and Algeria are 1483060, 204760392, 20 million, 230 and 44903225 respectively. In such countries their population is increasing every year by the rates of 5% , 14.2% , 6.5% , 0.18% and 0.1% respectively. Find the population of Muslims in those countries in 2040.

Solution1:

Population 4 year ago (p)= 256

Rate of increasing (i)= 16% =0.16

Time (t)= 4 year

Present population (p_t)= ?

We have, $p_t = e^{it}$

= 256× e^{it}

= 485.499

Thus, the present population of one-horned rhino is 485.

Solution2:

Population of city in 2000 (p)= 100000

Radioactive decay (i)= 3.5% =0.035

Time (t)= 40 years

Population in 2040 (p_t) = ?

We have,$p_t = e^{it}$

= 100000× $e^{0.035\times40}$

= 24659.696

Thus, the population of a city in 2040 will be 24659.

Solution3:

Let $I = I_\circ e^{0.1L}$

Find L when $I = 2I_\circ$

$$2I_\circ = I_\circ e^{0.1L}$$

$$e^{0.1L} = 2$$

$$\ln e^{0.1L} = \ln 2$$

$$L = \frac{\ln 2}{0.1}$$

= 6.93147

= 7 (nearest whole)

Thus, the loudness of sound must increase 7 decibels for the intensity to double.

Solution4:

We have,

$$\frac{1}{2}A(0) = A(0)e^{-0.0263t}$$

$$\Rightarrow \frac{1}{2} = e^{-0.0263t}$$

$$\Rightarrow \ln\left(\frac{1}{2}\right) = \ln(e^{-0.0263t})$$

$$\Rightarrow -0.693 = -0.263t\ln(e)$$

$$\Rightarrow -0.693 = -0.263t$$

$$\Rightarrow t = 26.35$$

Thus, it takes 26.35 years.

Solution5:

Population of Muslims in 2024 $(p) = 1.9$ billion

Rate of increasing $(i) = 2.2\ \% = 0.022$

Time $(t) = 26\ years$

We have,

$$p_t = pe^{it}$$

$$p_t = 1.9 \times e^{0.022 \times 26}$$

$$p_t = 3.37$$

Thus, the population of Muslims in 2050 will be nearly 3.37 billion.

Solution6:

Population of Muslim in Nepal

Population in 2024 $(p) = 1483060$

Increasing rate $(i) = 5\% = 0.05$

Time $((t) = 16\ years$

Population in 2040 $(p_t) =?$

We have,

$$p_t = pe^{it}$$

$$p_t = 1483060e^{0.05 \times 16}$$

$$p_t = 3300610.73$$

Thus, the population of Muslims in Nepal in 2040 is nearly 3300610

Population of Muslim in India

Population in 2024 $(p) = 204760392$

Increasing rate $(i) = 14.2\% = 0.142$

Time $(t) = 16\ years$

$$population\ in\ 2040\ (p_t) =?$$

We have,

$$p_t = pe^{it}$$

$$p_t = 204760392e^{16 \times 0.142}$$

$$p_t = 198595787$$

Thus, the population of Muslims in 2040 in India will be nearly 19859787.

Population of Muslims in China

$$population\ in\ 2024\ (p) = 20\ million$$

Increasing rate $(i) = 6.5\% = 0.065$

$$time(t) = 16\ years$$
$$population\ in\ 2040\ (p_t) = ?$$

We have,

$$p_t = pe^{it}$$
$$p_t = 20 \times e^{16\times 0.065}$$
$$p_t = 56.584\ million$$

Thus, the population of Muslims in 2040 will be nearly 56.584 million.

Population of Muslims in Japan

$$population\ in\ 2024\ (p) = 230$$

Increasing rate $(i) = 0.18\% = 0.0018$

$$time(t) = 16\ years$$
$$population\ in\ 2040\ (p_t) = ?$$

We have,

$$p_t = pe^{it}$$
$$p_t = 230 \times e^{16\times 0.0018}$$

$p_t = 236.72$

Thus, the population of Muslims in 2040 in Japan will be nearly 236.

Population of Muslims in Algeria

$$population\ in\ 2024\ (p) = 44903225$$

Increasing rate $(i) = 0.1\% = 0.001$

$$time(t) = 16\ years$$
$$population\ in\ 2040\ (p_t) = ?$$

We have,

$$p_t = pe^{it}$$
$$p_t = 44903225 \times e^{16\times 0.001}$$
$$p_t = 45627454.99$$

Thus, the population of Muslims in 2040 in Algeria will be nearly 25627455.

Conclusion:

In the solution of problem1, we found the population of one-horned rhino at present in Nepal. By using time interval, increasing rate, population at any time, we can also find the population of any other animals, plants as well as humans.

In the solution of problem2, we found the population of a certain city although the rate of population was on radioactive decay or in decreasing.

In the solution of problem3, we found the increase in loudness of sound then its intensity has doubled that is the loudness should be nearest whole to 7 decibels for its doubled intensity.

In the solution of problem4, we found the time which is more than enough to reduce the half of the weight of any substance. We obtain the time 26.35 years to make the weight half.

All above we can say that the exponential function has many applications in our real life. Like: population of one - horned rhino of Nepal, radioactive decay in population, weight of a certain substance, intensity and loudness of sound, carbon dating or finding the age of any substance by the help of carbon – 14 remained at that substance, etc. are the most common & important example for the real-life application of exponential functions.

In the situation of problem 5and 6, we explained about the Muslims population in the whole world as well as in some countries where Muslims are growing slowly like Algeria and Japan. Algeria has 99.1% of Muslim population in total but Japan have only 0.18% of Muslim population in total.

We found all those population only by the help of exponential functions using its application in real life, we predicted and got the result of future population of Muslims in the world and some other countries also.

So, all we can say is exponential function in mathematics is one of the important parts and gift for mathematics and its learners. Very much thanks to all the mathematicians involved in the research of exponential function mainly to Leonard Euler.

1. Sahani, S.K. et al.2023.The International Pricing of Risk; An Empirical Investigation of the World Capital Market Structure, American Journal of Science and Learning Development,Vol,2,No.7,49-65.
2. Sahani, S.K. and Prasad, K.S.2023.Study and Analysis of Input| Output Analysis to Non-Linear Science,ACCST Research Journal,Vol. XXL,No.1,22-30.
3. Sahani, S.K.2023.Youth on Employment and Job Creation in African Countries; Opportunities, Challenges, Characteristics Determinants and Performance of Self-Employment Among Them the Youth in African Countries, Central Asian Journal of Mathematics Theory and Computer Sciences, Vol.04, No.7, 27-41.
4. Sahani, S.K. et al.2023.Economic Insights Unveiled: A Journey Through Input-Output Analysis in Non-Linear Mathematics, MIKAILALSYS Journal of Multidisciplinary Science, Vol.1,Issue 1,240-259.
5. Sahani, S.K. et al.2023.Unraveling the Interdependence of Input and Output Analysis in Business Sector; A Case Study, International Journal of Education, Management, and Technology, Vol.1,Issue 1, 27-45.
6. Sharma, S., Sahani, S., Chaudhary, B., Sahani, K., &Sah, N. (2023). Asan, The Traditional Market of Kathmandu Valley: Analyzing Market Trend and Consumer Buying Behavior of Such Market.EDUMALSYS Journal of Research in Education Management, 1(2), 215-226. https://doi.org/10.58578/edumalsys.v1i2.2048
7. Sah, P., Sah, R., Sahani, S. K., & Sahani, K. (2024). Study and Analysis of Education System in Nepal and Its Challenges Along with Its Solution. Mikailalsys Journal of Advanced Engineering International, 1(1), 33-42. https://doi.org/10.58578/mjaei.v1i1.2792
8. Karn, P., Sahani, S. K., & Sahani, K. (2024). Study and Analysis of Some Practical Life Uses and Applications of Exponential Function. Mikailalsys Journal of Advanced Engineering International, 1(1), 43-56. https://doi.org/10.58578/mjaei.v1i1.2793
9. Sah, K. K., Sahani, S. K., Sahani, K., &Sah, B. K. (2024). A Study and Examined of Exponential Function: A Journey of Its Applications in Real Life. Mikailalsys Journal of Advanced Engineering International, 1(1), 23-32. https://doi.org/10.58578/mjaei.v1i1.2791

10. Sahani, S., &Karna, S. K. (2024). Analytical Study of Cooperative Organizations Based on Domestic Area of Asian Countries: A Classical Approach of Village. International Journal of Education, Management, and Technology, 2(1), 40-62. https://doi.org/10.58578/ijemt.v2i1.2850
11. Mahato, S. K., Sahani, S., Sahani, K., Sah, B. K., &Karna, S. K. (2024). Study and Analysis of Some Real Life Applications of Exponential Function. EDUMALSYS Journal of Research in Education Management, 2(1), 13-26. https://doi.org/10.58578/edumalsys.v2i1.2845
12. Sah, B. K., & Sahani, S. (2024). Poisson-New Quadratic-Exponential Distribution. Mikailalsys Journal of Mathematics and Statistics, 2(2), 27-45. https://doi.org/10.58578/mjms.v2i2.2862
13. Chaurasiya, P., Sharma, N., Chaudhary, S., Sah, S., Sahani, S., & Sahani, K. (2024). Study and Analysis of Some Real Life Applications of Exponential Function Based on Population Growth Rate of Nepal. Asian Journal of Science, Technology, Engineering, and Art, 2(3), 352-361. https://doi.org/10.58578/ajstea.v2i3.2863
14. Pandit, J. K., Sahani, S., & Sahani, K. (2024). Analysis of Some Practical Life Uses and Applications of Exponential Function. Journal of Multidisciplinary Science: MIKAILALSYS, 2(2), 179-192. https://doi.org/10.58578/mikailalsys.v2i2.2864
15. Sah, B. K., & Sahani, S. K. (2024). Premium Linear-Exponential Mixture of Poisson Distribution. Communications on Applied Nonlinear Analysis, 31(1), 187-199.
16. Sah, B. K., & Sahani, S. K. (2022). Polynomial-exponential distribution. Mathematical Statistician and Engineering Applications, 71(4), 2474-2486.
17. Sah, B. K., & Sahani, S. K. (2022). New Quadratic-Exponential Distribution. Journal of Pharmaceutical Negative Results, 2338-2351.
18. Sah, B. K., & Sahani, S. K. (2023). Polynomial-Exponential Mixture of Poisson distribution. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 14(03), 505-516.
19. Sah,B.K.andSahani,S.K.,(2022).Modified Linear-Exponentia Distribution. NeuroQuantology, 20(5), 3520.
20. Sah, B. K., & Sahani, S. K. Generalised Poisson-Modified Mishra distribution. Power System Technology, 48(1), 157 167. https://doi.org/10.52783/pst.261
21. Jha, S., Sahani, S.K., & Sahani, K. (2024). Research Paper Unveiling the Power of Exponential Functions: Applications in Our Daily Lives. ARZUSIN, 4(3), 402-409. https://doi.org/10.58578/arzusin.v4i3.2861
22. Karna, S. K., & Sahani, S.K. (2024). An Analytical Study of Deposit Collection and Fund Mobilization in DevelopngCountries : A Financial Apprroach to Nepalese Commercial Banks in Nonlinear Analysis. PALAPA, 12(1), 40-61. https://doi.org/10.36088/palapa.v12i1.4649
23. Karna, S. K. ., & Sahani, S. K. . (2024). An Empirical Study of Micro Finance Services and Participatory Self-development Expedition Acclerating in Developing Countries: An Approach to Rural Perspective of Nepal. EUROPEAN JOURNAL OF BUSINESS STARTUPS AND OPEN SOCIETY, 4(4), 119–134. Retrieved from https://inovatus.es/index.php/ejbsos/article/view/2938
24. Karna, S.K. and Sahani, S.K., (2024)A Statistical Analysis of Discrimination and Exploitation based on Ethnicity, Caste, Sex, Religion and Class in Developing Countries: A Graphical Study of Nepalese Societies, Vol.2, No.4,174-197,
25. Sah, B., Mandal, N., Sahani, S.K., & Sahani, K. (2024). Applications of Exponential Function in Our Real Lives. International Journal of Humanities, Education, and Social Sciences, 2(2), 144-153. https://doi.org/10.58578/ijhess.v2i2.2872.

26. Johansyaha, M., Nahar, J., Djauhari, E., Napitupulu,H.,&Saputra, J.,(2022),Determining the price elasticity of demand with and without memory effects using fractional order derivatives: A numerical simulation approach, Decision Science Letters 11(3), 311-322.
27. Oscar, Lange(1942), Theoretically derivation of elasticities of demand and supply : the direct method,Econometrica, Journal of the Econometrica Society, 193-214
28. Marsitin, R.,(2019), Analysis of differential calculus in economics, Journal of Physics: Conference series 1381 (1), 012003
29. Tarasova, Valentina V, & Tarasova, Vasily E (2016), Elasticity for economic processes with memory: Fractional differential calculus approach,Fractional Differential Calculus 6 (2), 219-232,
30. Tarasova, Vasily E(2019), On history of mathematical economics: Application of fractional calculus, Mathematics 7 (6), 509
31. Thirunavukkarasu, S. &Pradha, T Lakshmi(2023), Differential Calculus and its Application in Economics-A Study with Reference to Consumer Demand Theory, Centre for Development Economic 10 (17), 30-37
32. Sahani, S.K., Karna, S.K., Sharma, D.K, Sah, B.K., and Sahani, K.(2024), Information In The African Markets Bolstering Conventional Indices; A Review Of The Theory And Empirical Evidences, Educational Administration: Theory and Practice, Volume 30, Issue 5,6703-6710.
33. Karna, S.K., Sahani, S.K. & Sharma, D.K. (2024). Analysis of Stock Market Trends for Market Capitalization and Securities Management: An approach to Nepalese Stock Market, Vol.3, Issue 3, 217-259
34. Sah, A. K., Sah, D. K., Sah, M. K., Sahani, S., Sahani, K., Mandal, D., & Karna, S. (2024). Study and Analysis of Some Impact on GDP of Nepal by Increase the Exports and Decreasing Import, on Economic Growth of Nepal with the Help of Exponential Function. FONDATIA, 8(2), 168-176. https://doi.org/10.36088/fondatia.v8i2.4650
35. Shrestha, S. K., Thakur, A., Mandal, K., Purbay, R., Sahani, S., & Sahani, K. (2024). Classical Study of Real Life Applications of Exponential Function. Al-DYAS, 3(2), 779-789. https://doi.org/10.58578/aldyas.v3i2.3048
36. Thakur, A., Das, R., Sah, S., Sahani, S., & Sahani, K. (2024). Classical Study of Exponential Function and Their Applications. ANWARUL, 4(3), 560-568. https://doi.org/10.58578/anwarul.v4i3.2873
37. Sahani, S.K, Mandal, D. N., & Sahani, K. (2024). A Certain Studies on Mathematical Modeling: An Optimization Oriented the Replacement of Items whose Efficiency Deteriorates with Time. Journal of Multidisciplinary Science: MIKAILALSYS, 2(1), 1-12. https://doi.org/10.58578/mikailalsys.v2i1.2286
38. Jha, A., Sahani, S., Jha, A., & Sahani, K. (2023). Business Insights Unveiled: A Journey through Linear Programming Problems. Mikailalsys Journal of Mathematics and Statistics, 1(1), 1-14. https://doi.org/10.58578/mjms.v1i1.1948
39. Sah, A. K., Sah, D. K., Sah, M. K., Sahani, S., Sahani, K., Mandal, D., & Karna, S. (2024). Study and Analysis of Some Impact on GDP of Nepal by Increase the Exports and Decreasing Import, on Economic Growth of Nepal with the Help of Exponential Function. FONDATIA, 8(2), 168-176. https://doi.org/10.36088/fondatia.v8i2.4650