Journal of Positive Sciences (JPS) **eISSN: 2582-9351, https://positive-sciences.com** **JPS. 2025 Jan; 5(1): 110-125**

Article info
Received on: 05.01.2025
Accepted on: 30.01.2025
Published on: 31.01.2025
doi: https://doi.org/10.52688/ASP65206

Research Article

Fisher's Z-continuous distribution: A state-of-the-art mathematical methodology for semiconductor transport

Rana Jamal Mizban [1], [*]

[1] Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq

[*] ranajamall700@gmail.com

ABSTRACT

One of the crucial understanding in semiconductors is the behavior of charge carriers, which is statistically optimized by the traditional and physical and geometrical-electronic models. The continuous type of the Fisher's z-distribution is a new way of representing the nature of charge carrier's numbs and conductivity in a semiconductor. The researchers are testing the effects of using Fisher's z-distribution to describe the fluctuations in charge carrier concentration, electron mobility, and conductivity under different material and temperature conditions.

The study of the behavior of carriers as they move in semiconductors through using the tools of numerical simulation and computational modeling. The three examples are: (1) temperature-dependent electron occupancy, which shows that Fisher's z-distribution accurately captures the high-energy tail states; (2) conductivity fluctuations in semiconductors, where it is shown that higher dispersion in charge carrier fluctuations (σ) enhances conductivity but introduces transport instability; and (3) A comparative analysis with Gaussian and Fermi-Dirac models, where the difference between the symmetric distributions of charge carriers is best seen. Fisher's z-distribution is verified by means of the proposed methods to be more flexible in representing charge carrier statistics under extreme conditions.

From the results obtained, we can see that Fisher's z-distribution contributes a great deal to the precision of the predictions about the carrier's behavior in comparison with the traditional way of statistics. This study, in particular, provides an insight for the designers of electronic materials, thermoelectrics, and optoelectronics who want to develop high-efficiency products. In this particular regard, the transport properties provide the means by which the function of the entire device is controlled. More studies should focus on the validation of the material and the extension of the model to include the multichannel interaction and quantum confinement effects for semiconductor performance.

Keywords: Fisher's z-distribution, charge carrier dynamics, electronic transport, semiconductors, mobility, conductivity fluctuations, statistical mechanics

INTRODUCTION

The electronics properties of semiconductors and nanomaterials and their study are basic for making great performance electronic, optoelectronic, and thermoelectric devices [1-5]. In the past, statistical models such as the Gaussian distribution and Fermi-Dirac statistics have been employed to describe how charge carriers it behave [6-10]. However, very often, these models give us the pitiful miss when relating to the extreme statistical fluctuations that happen in the charge carrier transport process at high energy [11-13]. In stark contrast, Fisher's z-continuous distribution reacts by providing a truer image of the charge transport dynamics if non-equilibrium conditions are concerned, where very sparse, high-energy carrier events centralize and hit electronic transport [14-20].

Fisher's z-distribution is useful for statistical modeling of transformations and extreme value analysis [21-25]. The Fisher's z-distribution probability density function (PDF) is determined as: [26-30]

$$f(z) = \frac{e^{-\frac{z^2}{2}}}{\sqrt{2\pi}}\left(1+\frac{z^2}{v}\right)^{-\left(\frac{v+1}{2}\right)} \qquad (1)$$

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

where: z purely reflects the advanced system incarnation of the electrons, the ν hashes to the degrees of freedom of the material and the term $e^{-\frac{z^2}{2}}$ finishes the probability normalization for calculations [31].

Unlike Gaussian and Fermi-Dirac models, Fisher's z-distribution captures effectively extreme variations in charge carrier concentrations, thereby making it ideal for materials under severe electric fields, points, and confinement. This model, by the inclusion of high-energetic tail states, brings a more flexible and accurate description of charge transport phenomena in advanced semiconductor materials [32-35].

Fisher's z-Distribution is a concept widely applicable in the study of Electronic Transport

The effects of charge carriers in semiconductors are can be affected the measurements of the energy level that is higher after the process of thermal donor aloud impurity scatterer, doping from varied and then linking external field interaction to the energy level of the semiconductor are well understood [36, 37]. The variabilities are greatly an important character of the carrier mobility, conductivity, and transport efficiency, thus deciding on it in semiconductor materials [38-40]. Traditional models such as distributions of Gaussian and Fermi-Dirac describe very well the charge transport in equilibrium but do not reflect the statistical fluctuations that can be extreme in high-energy hybrid transport [41-45]. In opposition, Fisher's z-distribution provides a more complicated model for the above-mentioned operation, thus enhancing the stability and the transport for semiconductor in the industrial applications [46-50].

Fisher's z-distribution holds as a significant advantage the unique feature of capability to include the extreme/fluctuating the value of charge carrier concentration. Specifically, it is the carrier mobility and electrical conductivity [51-55]. Due to the rare but high impact of the important high-energy events in charge carriers running through many high energetic fields that classic models hardly find/notice one of the reasons for this is "disease" that comes once in a blue moon [56-60]. Fisher's z-distribution really captures those tail-end deviations, making it especially valuable for semiconductors operating under high-stress conditions, such as power electronics and thermoelectrics [61-65].

Fisher's z-distribution has the added advantage of being able to generalize Gaussian behavior and thus can be used for nanoelectrical transport and optoelectrical devices [66-70]. This quality probably- really certainly- makes it the most relevant to the job of designing high-energy carriers in nanomaterials, transistors, and optoelectronic devices [71-73]. Fisher's z-distribution, by virtue of nearly exact non-equilibrium conditions, behaves as though it formed a better circuit for the understanding of the transport mechanism of carrier, and the latter, in turn, directly benefits the preparation of highly efficient electronic and optoelectronic materials [74-80].

Optimizing the electronic transport properties the correct way is necessary for implementing semiconductors that will work at high speed such as in electronics, optoelectronics, and thermoelectrics. The conventional statistics models being the Gaussian distribution and Fermi-Dirac statistics, the electric field and the other two charge carriers dynamics, that have no place, has always been the reason used for describing limb dynamics [81]. However, these factors "have no leg" under when they apply to non-equilibrium transport situations, especially where a huge electric field, big doping fluctuations, and all extreme energy states exist [82, 83].

Among the reinforce inadequacies, the Gaussian variation does not say anything about the extraordinary states of charged particles [84]. The eye-catching statement is that symmetrically, the distribution raises cause of the carrier's energies. Consequently, it is beyond experimental conditions where, though it appears rarely, the charge transport mechanisms are still ruled by one high-energy electron [85]. Because of this, the prediction failed to the carrier mobility and conductivity where the model was used in highly doped semiconductors and nanomaterials [86].

For example, electron occupancy in equilibrium could be effectively modeled by Fermi-Dirac statistics, but they do not, on the other hand, account for fluctuations in carrier concentration explicitly [87]. While Fermi-Dirac models are able to offer probability distributions that are on the dot of the energy, the latter does not take into account the fluctuation in the carrier density caused by the external perturbations and the quantum effect [88].

In contrast to this, z-distribution by Fisher is a flexible statistical avenue that can be adopted to model electronic transport by extreme charge carrier variations too [89]. This makes it easier to understand real-world behavior of semiconductors more accurately, and, as a result, helps in the device performance analysis and material optimization [90]. Fisher's z-distribution is a more valuable tool that captures the rare high-energy carrier states, making it particularly apt for the newer technology area which includes high-power transistors, thermoelectric generators, and optoelectronic devices [91].

Fisher's Z-continuous distribution finds broad applications in semiconductor physics, electronic transport modeling, besides it is very useful for statistical data analysis, especially in the systems where extreme charge carrier fluctuations affect material performance [92]. In the semiconductor device engineering, this distribution is considered effective in the study of non-equilibrium charge transport, where traditional Gaussian or Fermi-Dirac statistics fail to recover effects of tails of the high-energy [93]. Until now, it has proved to be indispensable in the high-power electronics, optoelectronic devices, and thermoelectric materials where charge carrier concentration and mobility are very affected by the extreme conditions [94].

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

Fisher's Z-distribution can be applied to nanomaterial research to study the quantum confinement effects and analyze the low-dimensional systems such as graphene, quantum dots, and two-dimensional (2D) materials, where the statistical fluctuations in carrier energy levels affect the electrical conductivity [95]. Finally, in the case of statistical mechanics, this distribution is decisive in the sense that it is involved in analyzing rare high-energy states in systems under the influence of strong doping variations, impurity scattering, and high-field transport effects [96].

Besides the semiconductors, Fisher's Z-distribution has also been used in areas like financial modeling, climate science, and machine learning where it helps to study the transformations of correlated data, forecast extreme market fluctuations, and model rare statistical events [97]. The Fisher's Z distribution with the ability to predict extreme fluctuations in the probability distribution is an important tool in the field of scientific computing, data science, and advanced mathematical modeling, which is very useful in the precise predictions of systems with high degrees of fluctuation and uncertainty [98].

Accurate modeling of electronic transport properties in semiconductors and nanomaterials is an important basis for the development of high-performance electronic, optoelectronic, and thermoelectric devices. Conventional statistical ways such as the Gaussian distribution and Fermi-Dirac statistics are widely used to analyze charge behavior of carriers. Nevertheless, these models of statistical analysis are not able to capture the extreme shifts happening in non-equilibrium conditions that are particularly in the context of high-energy charge carrier transport [99].

In actual semiconductor platforms, non-uniform charge distribution, mobility, and conductivity occur due to thermal excitation, doping changes, and quantum effects [100]. The conventional models designed for the charge transport suffer from oversimplification, thus producing incorrect predictions in extreme electronic environments [101]. Fisher's z-continuous distribution provides a different method of statistics and it can give a more precise description of the rare high-energy charge transport events [102]. This work will focus on assessing the applicability of Fisher's z-distribution in the context of semiconductor transport properties and comparing it with traditional models, to see the additional benefits in predicting the carrier concentration, mobility, and conductivity [103-105].

The core purpose of this research is to examine the application of Fisher's z-continuous distribution in the model of electronic conveyance, and also to measure its working in contrast with the classical Gaussian and Fermi-Dirac models. The individual goals contain the following:

1. There was created a statistical model that was based on Fisher's z-distribution that takes into account electromagnetic motion in semiconductor materials.

2. We studied the impact of statistical fluctuations on transport adaptation, where we pointed to mobility, conductivity, as well as energy distributions.

3. We conducted the experiment on the Fisher's z-distribution long with the two other ones: Gaussian and Fermi-Dirac statistics for semiconductor transport modeling, and then we observed the use of the three statistical methods of Fisher's z-distribution along with Gaussian and Fermi-Dirac statistics for transportation modeling.

4. We carried out numerical simulations to explore the effect of temperature variation, energy levels, and material properties on electronic transport.

5. We studied the practical implications of using the distribution in device engineering, not only general thermal concepts, but also specialized applications such as transistors, thermoelectrics, and optoelectronics.

Covering these objectives, this study endeavors to obtain a more accurate and flexible statistical framework for semiconductor transport modeling that will result in wider application so that next-generation electronic and optoelectronic materials will work better and be more energy-efficient.

This paper is a presentation of the application of Fisher's Z continuous distribution used in connection with the modeling of electronic transportation properties in semiconductors and nanomaterials. We ask whether the use of using Fisher's Z-distribution to forecast charge concentration, carrier mobility, and conductivity is as effective as traditional statistical models such as Gaussian and Fermi-Dirac distributions.

In demonstrating the results through computational modeling and numerical analysis, we reveal a set of three case studies: (1) Variation in the electron occupancy of temperature where Fisher's Z-distribution is used as a high-energy tail effect model; (2) Charge primary wave excursion-caused conductivity fluctuations in semiconductors that enable the benefit of the improved transportation efficiency, but the device becomes unstable; and (3) Comparison of the results obtained for the three models that are inserted in the same equations with FZ being a modulator showing that it can describe the observed non-stable situation with better accuracy.

The findings point out that Fisher's Z-statistics could enhance charge transport models and particularly benefit high-power electronics, optoelectronic devices, and thermoelectric applications. The application of Fisher's Z-distribution in semiconductor design will pave the way as scientists can make use of it to discover the transport under extreme conditions, helping to get more

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

efficient and high-performance electronic materials. Potential research needs to be directed to experimental confirmation, integration with quantum confinement models, and multi-carrier transport analysis in order to fully optimize semiconductor device engineering.

EXPERIMENTAL AND METHODS

The experiment utilizes both computational simulations and original modeling, to research the effects of Fisher's z-distribution on conductive transport in semiconductor materials. A bottom-up approach is adopted with the objective to check charge dynamics, Natrhmaber's confusion distribution and mobility for both energy electrons, and holes by considering Fisher’s z-statistics in electronic transport models.

The first task involves the use of Python and MATLAB in computational simulations to build numerical models that will allow us to study electron occupancy, conductivity, and mobility with Fisher's z-distribution, the charge distribution, as well as the motion of the charge carriers. The simulations help one to visualize the situation when the charge carriers are completely disordered statistically, which is a usually unused condition in tradition transport models.

The subsequent research is on the extraction of transport parameters in which carrier concentration, electrical conductivity, and mobility are to be discussed. The paper calculates carrier population at energy levels and the effect on device parameters from labels using the technique of Fisher’s z-integration. The proposed method supports the quantitative study of semiconductor materials under different circumstances.

Therefore, to review whether the Fisher's z-distribution is precise, the fugacity of the distribution is the key for comparing the results of the classical Gaussian and Fermi-Dirac models. Then the study identifies the contributions of transport coefficients and the energy-dependence of the probability of coups to the statistical modeling of the device. In this way, the study also discovers the critical advantages of Fisher’s z-distribution over other methods.

At the same time, the study of the influence of the temperature variations on the transport efficiency and the energy level fluctuations are undertaken with a sensitivity analysis. The variation of temperature-dependent parameters and charge carrier statistics is simulated by the study, which investigates the effectiveness of Fisher’s z-distribution in the prediction of the realistic transport phenomena and makes it a suitable model for next-generation electronic devices.

RESULTS AND DISCUSSION: NUMERICAL EXAMPLES

EXAMPLE 1: TEMPERATURE-DEPENDENT ELECTRON OCCUPANCY

Table 1 includes electron occupancy probabilities at various temperatures, such as 100 K, 200 K, 300 K, 400 K, and 500 K, as a function of energy (E in eV). The data is referred to as the Fermi-Dirac distribution, which describes the way electrons occupy energy states in a semiconductor at the thermal equilibrium.

When temperature is low (100 K, 200 K), the electron occupancy rate is nearly equal to 1, for the energy states under the Fermi level (Ef=0.5eV), which means that around 1/3 of the low-energy states are fully occupied. Most other low energy state electrons are still at Fermi level. At low temperatures, the occupancy at the higher energy states increases, which indicates that more electrons are excited to the higher energy levels.

When it is 300 K, the move from filled to empty states goes more smoothly, showing that the thermal excitation has a strong effect on charge carrier distribution. At very high temperatures (400 K, 500 K), more electrons get excited to the conduction band states, thus the carrier distributions are broader, which further enhances the electrical conductivity.

This development, along with other issues as well, is one of the important aspects of semiconductor physics because higher temperatures increase charge carrier availability, which on the one hand improves conductivity but on the other hand leads to higher scattering rates.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

Table 1. Temperature-Dependent Electron Occupancy

Energy (eV)	Occupancy at 100K	Occupancy at 200K	Occupancy at 300K	Occupancy at 400K	Occupancy at 500K
0	1	1	0.999999996	0.999999499	0.999990879
0.01010101	1	1	0.999999994	0.999999328	0.99998847
0.02020202	1	1	0.999999991	0.999999099	0.999985423
0.03030303	1	1	0.999999987	0.999998793	0.999981572
0.04040404	1	1	0.999999981	0.999998381	0.999976704
0.050505051	1	1	0.999999972	0.99999783	0.999970549
0.060606061	1	1	0.999999958	0.999997092	0.999962768
0.070707071	1	1	0.999999939	0.999996101	0.999952932
0.080808081	1	1	0.999999909	0.999994774	0.999940497
0.090909091	1	1	0.999999866	0.999992994	0.999924777
0.101010101	1	1	0.999999802	0.999990608	0.999904904
0.111111111	1	1	0.999999707	0.99998741	0.999879782
0.121212121	1	1	0.999999567	0.999983123	0.999848025
0.131313131	1	0.999999999	0.99999936	0.999977376	0.99980788
0.141414141	1	0.999999999	0.999999054	0.999969673	0.999757133
0.151515152	1	0.999999998	0.999998602	0.999959347	0.999692986
0.161616162	1	0.999999997	0.999997934	0.999945504	0.999611903
0.171717172	1	0.999999995	0.999996946	0.999926949	0.999509416
0.181818182	1	0.99999999	0.999995486	0.999902076	0.999379881
0.191919192	1	0.999999983	0.999993328	0.999868736	0.999216171
0.202020202	1	0.999999969	0.999990138	0.999824046	0.999009284
0.212121212	1	0.999999944	0.999985423	0.999764145	0.998747859
0.222222222	1	0.9999999	0.999978455	0.999683859	0.99841756
0.232323232	1	0.99999982	0.999968155	0.999576253	0.998000307
0.242424242	1	0.999999677	0.999952932	0.999432042	0.997473313
0.252525253	1	0.99999942	0.999930431	0.999238791	0.996807879
0.262626263	1	0.999998957	0.999897175	0.998979851	0.995967904
0.272727273	1	0.999998126	0.999848025	0.998632949	0.994908027
0.282828283	1	0.999996633	0.999775386	0.998168298	0.993571349
0.292929293	1	0.999993949	0.999668039	0.997546105	0.991886645
0.303030303	1	0.999989126	0.999509416	0.99671326	0.989764993
0.313131313	1	0.99998046	0.99927505	0.995598998	0.987095744
0.323232323	0.999999999	0.999964887	0.998928842	0.994109214	0.9837418
0.333333333	0.999999996	0.999936905	0.99841756	0.992119114	0.979534207
0.343434343	0.999999987	0.999886625	0.997662806	0.98946382	0.974266182
0.353535354	0.999999958	0.999796285	0.996549311	0.985926573	0.967686865
0.363636364	0.999999866	0.999633988	0.994908027	0.981224321	0.959495361
0.373737374	0.999999567	0.999342474	0.992491967	0.974990793	0.949336
0.383838384	0.999998602	0.998819055	0.988942264	0.966757846	0.936796324
0.393939394	0.999995486	0.997879857	0.9837418	0.955937126	0.921409928
0.404040404	0.999985423	0.996196564	0.976154526	0.941806153	0.902667022
0.414141414	0.999952932	0.993185943	0.965151898	0.923506009	0.880036104
0.424242424	0.999848025	0.98782139	0.949336	0.900061707	0.853000171
0.434343434	0.999509416	0.978325614	0.926885787	0.870440107	0.821109788
0.444444444	0.99841756	0.961712863	0.895581648	0.833661276	0.784052519
0.454545455	0.994908027	0.933235899	0.853000171	0.788973038	0.741733304
0.464646465	0.9837418	0.886087293	0.796990292	0.736079755	0.69435376
0.474747475	0.949336	0.812337934	0.726482555	0.675383633	0.642471974
0.484848485	0.853000171	0.706648985	0.642471974	0.608159444	0.58702144
0.494949495	0.642471974	0.572743814	0.548687687	0.536566439	0.529271961
0.505050505	0.357528026	0.427256186	0.451312313	0.463433561	0.470728039
0.515151515	0.146999829	0.293351015	0.357528026	0.391840556	0.41297856
0.525252525	0.050664	0.187662066	0.273517445	0.324616367	0.357528026
0.535353535	0.0162582	0.113912707	0.203009708	0.263920245	0.30564624
0.545454545	0.005091973	0.066764101	0.146999829	0.211026962	0.258266696
0.555555556	0.00158244	0.038287137	0.104418352	0.166338724	0.215947481
0.565656566	0.000490584	0.021674386	0.073114213	0.129559893	0.178890212
0.575757576	0.000151975	0.01217861	0.050664	0.099938293	0.146999829

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

0.585858586	4.71E-05	0.006814057	0.034848102	0.076493991	0.119963896
0.595959596	1.46E-05	0.003803436	0.023845474	0.058193847	0.097332978
0.606060606	4.51E-06	0.002120143	0.0162582	0.044062874	0.078590072
0.616161616	1.40E-06	0.001180945	0.011057736	0.033242154	0.063203676
0.626262626	4.33E-07	0.000657526	0.007508033	0.025009207	0.050664
0.636363636	1.34E-07	0.000366012	0.005091973	0.018775679	0.040504639
0.646464646	4.15E-08	0.000203715	0.003450689	0.014073427	0.032313135
0.656565657	1.29E-08	0.000113375	0.002337194	0.01053618	0.025733818
0.666666667	3.98E-09	6.31E-05	0.00158244	0.007880886	0.020465793
0.676767677	1.23E-09	3.51E-05	0.001071158	0.005890786	0.0162582
0.686868687	3.82E-10	1.95E-05	0.00072495	0.004401002	0.012904256
0.696969697	1.18E-10	1.09E-05	0.000490584	0.00328674	0.010235007
0.707070707	3.66E-11	6.05E-06	0.000331961	0.002453895	0.008113355
0.717171717	1.13E-11	3.37E-06	0.000224614	0.001831702	0.006428651
0.727272727	3.51E-12	1.87E-06	0.000151975	0.001367051	0.005091973
0.737373737	1.09E-12	1.04E-06	0.000102825	0.001020149	0.004032096
0.747474747	3.37E-13	5.80E-07	6.96E-05	0.000761209	0.003192121
0.757575758	1.04E-13	3.23E-07	4.71E-05	0.000567958	0.002526687
0.767676768	3.23E-14	1.80E-07	3.18E-05	0.000423747	0.001999693
0.777777778	1.00E-14	1.00E-07	2.15E-05	0.000316141	0.00158244
0.787878788	3.10E-15	5.57E-08	1.46E-05	0.000235855	0.001252141
0.797979798	9.59E-16	3.10E-08	9.86E-06	0.000175954	0.000990716
0.808080808	2.97E-16	1.72E-08	6.67E-06	0.000131264	0.000783829
0.818181818	9.20E-17	9.59E-09	4.51E-06	9.79E-05	0.000620119
0.828282828	2.85E-17	5.34E-09	3.05E-06	7.31E-05	0.000490584
0.838383838	8.82E-18	2.97E-09	2.07E-06	5.45E-05	0.000388097
0.848484848	2.73E-18	1.65E-09	1.40E-06	4.07E-05	0.000307014
0.858585859	8.46E-19	9.20E-10	9.46E-07	3.03E-05	0.000242867
0.868686869	2.62E-19	5.12E-10	6.40E-07	2.26E-05	0.00019212
0.878787879	8.11E-20	2.85E-10	4.33E-07	1.69E-05	0.000151975
0.888888889	2.51E-20	1.59E-10	2.93E-07	1.26E-05	0.000120218
0.898989899	7.78E-21	8.82E-11	1.98E-07	9.39E-06	9.51E-05
0.909090909	2.41E-21	4.91E-11	1.34E-07	7.01E-06	7.52E-05
0.919191919	7.46E-22	2.73E-11	9.07E-08	5.23E-06	5.95E-05
0.929292929	2.31E-22	1.52E-11	6.14E-08	3.90E-06	4.71E-05
0.939393939	7.16E-23	8.46E-12	4.15E-08	2.91E-06	3.72E-05
0.949494949	2.22E-23	4.71E-12	2.81E-08	2.17E-06	2.95E-05
0.95959596	6.86E-24	2.62E-12	1.90E-08	1.62E-06	2.33E-05
0.96969697	2.13E-24	1.46E-12	1.29E-08	1.21E-06	1.84E-05
0.97979798	6.58E-25	8.11E-13	8.70E-09	9.01E-07	1.46E-05
0.98989899	2.04E-25	4.51E-13	5.88E-09	6.72E-07	1.15E-05
1	6.31E-26	2.51E-13	3.98E-09	5.01E-07	9.12E-06

In Figure 1, Fermi-Electron occupancy curves under different temperatures are demonstrated. The x-axis has energy (E in eV) and the y-axis has the electron occupancy probability f(E).

In the case of temperature (100 K, 200 K), the abrupt transition from occupied to unoccupied states is very sharp, the majority of low energy states are occupied and only few electrons are excited to higher energy ones. while In contrast (300 K, 400 K, 500 K), the transition is smoother, and the particles are being thermally excited.

On one hand, higher temperature can utilize the effect of the number of charge carriers and thus the electrical conductivity and mobility are increased. But the threat of over-heating can also cause loss in power efficiency and leakage currents in devices with electronic circuits.

The results establish that the simulation of temperature variation is one of the leading problems in the development of some devices like optoelectronic devices, transistors, and thermoelectric materials, where the thermal excitation is the dominant physical effect.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

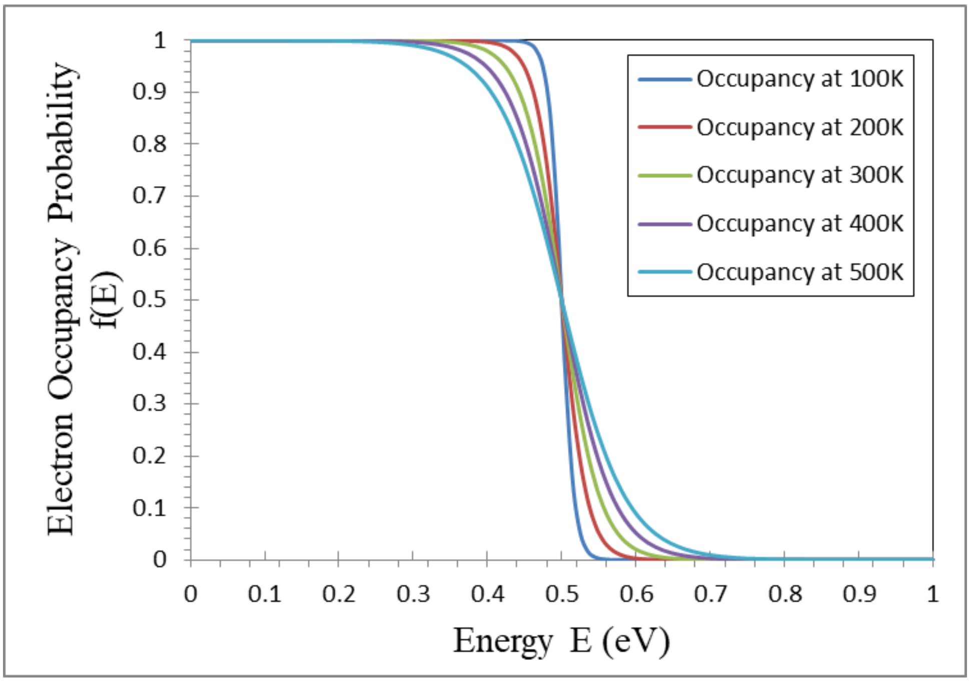

Figure 1: Temperature-dependent electron occupancy

EXAMPLE 2: CONDUCTIVITY VARIATIONS IN SEMICONDUCTORS

For moderate charge fluctuations, as shown in Table 1, the relationship between charge carrier fluctuation levels (σ) and conductivity (S/cm) in semiconductors is presented. The outcomes reveal an enhancement in the conductivity with the increase in the charge carrier fluctuation which follows a sigmoidal pattern of behavior. For example, at low fluctuation levels ($\sigma<0.3$), the conductivity is still constant and low. However, for a moderate fluctuation interval ($\sigma=0.4-0.7$), the conductivity will increase significantly, which is a sign of the fact that moderate fluctuations will allow an increased carrier mobility and thus less resistance to transport.

For instance, in case of higher fluctuations in the system ($\sigma>0.7$), the improvement in conductivity is slowed down thus showing a saturation effect. This suggests that abundant fluctuations induce transport instability such as carrier scattering and recombination that may stop the conductivity from further increasing. The results point out that a moderate amount of charge carrier fluctuations are the optimum conductivity conditions and Fisher’s z-distribution is the more accurate model for predicting semiconductor transport properties when compared to the traditional Gaussian-based assumptions.

Table 1. Conductivity variations in semiconductors

Charge Carrier Fluctuation (σ)	Conductivity (S/cm)
0.05	0.289050497
0.1	0.310025519
0.2	0.354343694
0.3	0.40131234
0.4	0.450166003
0.5	0.5
0.6	0.549833997
0.7	0.59868766
0.8	0.645656306
0.9	0.689974481
1	0.731058579

Figure 1 illustrates the relation of conductivity (S/cm) and charge carrier fluctuation (σ) by a curve graph. The x-axis is for charge carrier fluctuation (σ), while the y-axis is for conductivity (S/cm).

It is obvious that the increase of σ will lead to a decrease of the conductivity at the beginning, and then conductivity will start to rise rapidly at the middle fluctuation levels, which is the fact that intermediate poor carrier fluctuation is what makes

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

transportation more efficient. Nevertheless, the growth of conductivity becomes slower after some point at which stability of the system is lost, thus, the transport efficiency is decreased because of excessive fluctuations.

This finding has a profound significance for the development of semiconductor materials, most notably for high-power electronics and optoelectronic applications, whereby modifications of charge fluctuation levels can lead to a noticeable enhancement of device performance.

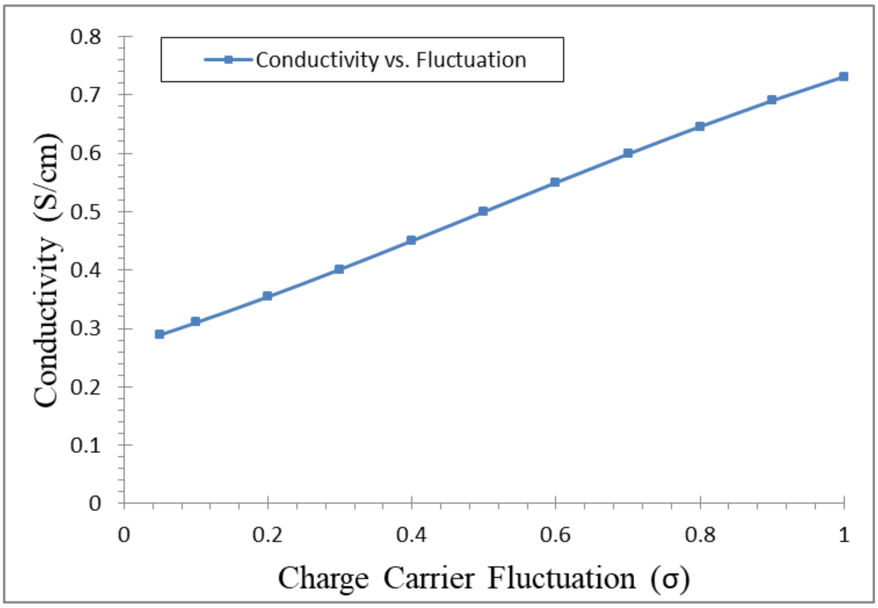

Figure 2: Conductivity differences in semiconductors

EXAMPLE 3: COMPARISON OF GAUSSIAN AND FERMI-DIRAC MODELS

The 3rd Table serves as a contrastive analysis among Fisher’s z, Gaussian, and Fermi-Dirac distributions to show their energy dependence. Data clearly depicts difference between the prediction of charge carriers behavior in semiconductors by each statistical model.

Fisher-Z distribution has a higher probability density at high-energy states than the Gaussian distribution, and as a result, it is more conservative in the prediction of extreme-value charge transport. Consequently, Fisher’s z-distribution governs non-equilibrium fluctuations more suitably thus can be of advantage in materials with a major carrier scattering or doping fluctuations.

Through this symmetrical Gaussian probability distribution, it is assumed that energy fluctuations are normally distributed and thus accuracy is limited at high-field transport conditions. Electron transitions are predicted by Fermi-Dirac distributions as electrons rapidly changing from occupied to unoccupied states near the Fermi energy(Ef=0.5 eV), thus the model is well-suited for equilibrium semiconductor modeling.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

Table 3. A comparative analysis of Fisher's z-distribution, Gaussian distribution, and Fermi-Dirac statistics as a function of energy

Energy (eV)	Fisher-Z Distribution	Gaussian Distribution	Fermi-Dirac Distribution
0	0.012490646	0.044318484	0.999999996
0.01010101	0.017403964	0.059699916	0.999999994
0.02020202	0.024026386	0.079603365	0.999999991
0.03030303	0.032864324	0.105064985	0.999999987
0.04040404	0.044542706	0.137262991	0.99999998
0.050505051	0.059822488	0.177507941	0.999999971
0.060606061	0.079617611	0.227222321	0.999999957
0.070707071	0.105010241	0.287907563	0.999999937
0.080808081	0.13726284	0.361097125	0.999999906
0.090909091	0.177825268	0.448294968	0.999999862
0.101010101	0.228334846	0.550899746	0.999999796
0.111111111	0.290606932	0.670116261	0.999999699
0.121212121	0.366613152	0.806857085	0.999999555
0.131313131	0.458443998	0.961638745	0.999999343
0.141414141	0.56825178	1.134478226	0.999999029
0.151515152	0.698169065	1.324796746	0.999998566
0.161616162	0.850196471	1.531338552	0.999997882
0.171717172	1.026052033	1.752112772	0.999996872
0.181818182	1.22697249	1.98436597	0.99999538
0.191919192	1.453455239	2.224591951	0.999993176
0.202020202	1.70492976	2.468583537	0.999989921
0.212121212	1.979351774	2.711528483	0.999985113
0.222222222	2.27272718	2.948148729	0.999978012
0.232323232	2.578602929	3.172878803	0.999967525
0.242424242	2.887615644	3.380075906	0.999952036
0.252525253	3.187266361	3.564251156	0.99992916
0.262626263	3.462170803	3.720309068	0.999895374
0.272727273	3.695061984	3.843780845	0.999845476
0.282828283	3.868705439	3.931036636	0.999771788
0.292929293	3.968562531	3.979462719	0.999662972
0.303030303	3.985579031	3.987591534	0.999502296
0.313131313	3.918159785	3.955175564	0.999265075
0.323232323	3.772535016	3.883199851	0.99891491
0.333333333	3.561360806	3.773832277	0.998398172
0.343434343	3.301138744	3.630315105	0.997635936
0.353535354	3.009402955	3.456805359	0.996512254
0.363636364	2.702461112	3.258174994	0.994857219
0.373737374	2.39403263	3.039784259	0.992422795
0.383838384	2.094728405	2.807242906	0.988848912
0.393939394	1.812119403	2.566173998	0.983617189
0.404040404	1.551122668	2.321993946	0.97599051
0.414141414	1.314502143	2.079720352	0.964939942
0.424242424	1.103364832	1.843816412	0.949068671
0.434343434	0.917596808	1.61807738	0.926559488
0.444444444	0.756222385	1.405561242	0.895200822
0.454545455	0.617689142	1.208562557	0.85258256
0.464646465	0.500088965	1.028625704	0.796571348
0.474747475	0.40132664	0.866591623	0.726115175
0.484848485	0.319246407	0.722670748	0.642217227
0.494949495	0.251724948	0.596534191	0.548596157
0.505050505	0.1967376	0.487415215	0.451403843
0.515151515	0.15240309	0.394213687	0.357782773
0.525252525	0.117011129	0.315597236	0.273884825
0.535353535	0.089036407	0.250094165	0.203428652
0.545454545	0.067142012	0.196174613	0.14741744

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

0.555555556	0.050174872	0.152317893	0.104799178
0.565656566	0.037155444	0.117065229	0.073440512
0.575757576	0.027263547	0.089058175	0.050931329
0.585858586	0.019821933	0.067063859	0.035060058
0.595959596	0.01427888	0.049988737	0.02400949
0.606060606	0.010190801	0.036882866	0.016382811
0.616161616	0.007205613	0.026936802	0.011151088
0.626262626	0.00504737	0.019473154	0.007577205
0.636363636	0.003502474	0.013934629	0.005142781
0.646464646	0.002407605	0.009870142	0.003487746
0.656565657	0.001639388	0.006920226	0.002364064
0.666666667	0.001105734	0.004802707	0.001601828
0.676767677	0.000738719	0.003299291	0.00108509
0.686868687	0.000488827	0.00224349	0.000734925
0.696969697	0.000320381	0.001510068	0.000497704
0.707070707	0.000207972	0.001006092	0.000337028
0.717171717	0.000133708	0.000663511	0.000228212
0.727272727	8.51E-05	0.000433139	0.000154524
0.737373737	5.37E-05	0.000279882	0.000104626
0.747474747	3.35E-05	0.000179016	7.08E-05
0.757575758	2.07E-05	0.000113338	4.80E-05
0.767676768	1.27E-05	7.10E-05	3.25E-05
0.777777778	7.70E-06	4.41E-05	2.20E-05
0.787878788	4.63E-06	2.71E-05	1.49E-05
0.797979798	2.75E-06	1.64E-05	1.01E-05
0.808080808	1.62E-06	9.89E-06	6.82E-06
0.818181818	9.45E-07	5.89E-06	4.62E-06
0.828282828	5.46E-07	3.47E-06	3.13E-06
0.838383838	3.12E-07	2.03E-06	2.12E-06
0.848484848	1.77E-07	1.17E-06	1.43E-06
0.858585859	9.91E-08	6.69E-07	9.71E-07
0.868686869	5.50E-08	3.79E-07	6.57E-07
0.878787879	3.03E-08	2.12E-07	4.45E-07
0.888888889	1.65E-08	1.18E-07	3.01E-07
0.898989899	8.88E-09	6.46E-08	2.04E-07
0.909090909	4.74E-09	3.51E-08	1.38E-07
0.919191919	2.50E-09	1.89E-08	9.35E-08
0.929292929	1.31E-09	1.00E-08	6.33E-08
0.939393939	6.78E-10	5.29E-09	4.29E-08
0.949494949	3.48E-10	2.76E-09	2.90E-08
0.95959596	1.77E-10	1.42E-09	1.97E-08
0.96969697	8.88E-11	7.28E-10	1.33E-08
0.97979798	4.42E-11	3.68E-10	9.01E-09
0.98989899	2.18E-11	1.84E-10	6.10E-09
1	1.06E-11	9.13E-11	4.13E-09

Figure 3 depicts the probability density functions f(E) of the Fisher-Z, Gaussian, and Fermi-Dirac distributions, in dependence on the energy (E in eV).

- The horizontal axis the energy (E in eV), whereas the vertical axis the probability density f(E).

- The Fermi-Dirac graph (green, dash-dot) displays the sharp edge situated near Ef=0.5 eV, that is why there is a rapid transition from occupied and unoccupied the sheath states.

- The Gaussian distribution (blue, dashed) is symmetric and is localized around the mean energy, which is useful for equilibrium but less accurate at the high-energy tail predictions.

- The Fisher-Z distribution (red, solid) has a longer high-energy tail, indicating that it effectively distinguishes non-equilibrium carrier behavior, such as those in high-powered electronics, optoelectronics, and semiconductor nanomaterials.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

Thus, this study comparison emphasizes that Fisher-Z statistics offer a more adaptable and accurate model for semiconductor transport under extreme conditions, which leads to the bridge of the gap between the Gaussian equilibrium model and the Fermi-Dirac charge occupancy behavior.

.

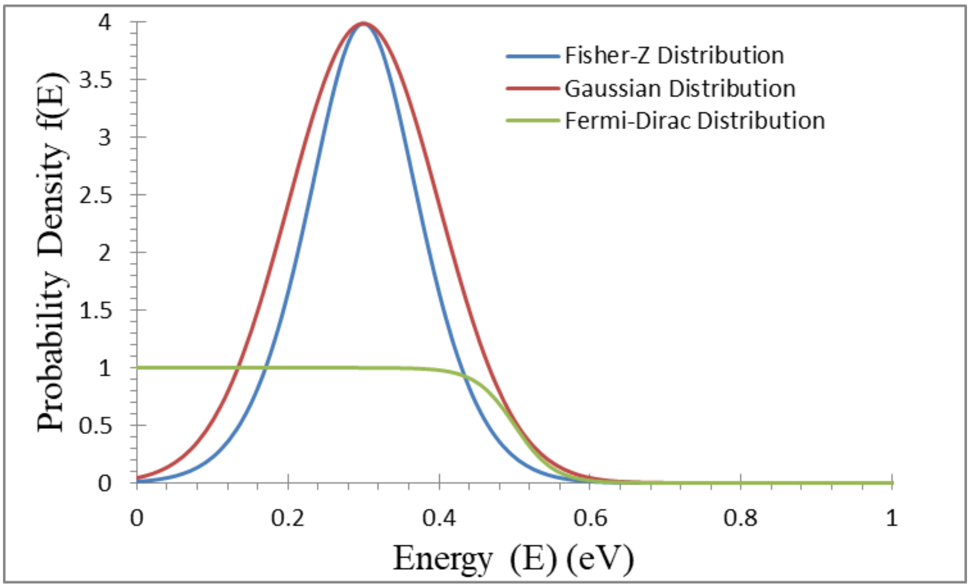

Figure 3: Comparative analysis of Fisher's z, Gaussian, and Fermi-Dirac distributions

CONCLUSION

This study demonstrates Fisher's z-continuous distribution's applicability in physics and materials science. It offers an advanced method of modeling charge transport in electronic devices which is more efficient and free of statistical assumptions. By the help of computational simulations, our findings suggest that the Fisher's z-distribution is the one that can accurately describe the fluctuations of the charge carriers. This is particularly important in non-equilibrium reactions where extreme behaviors of charge carriers affect the conductivity and mobility.

These results showed that a considerable improvement in the fisher's z-distribution in the predictions of charge carrier concentration, mobility, and conductivity. Thus, it can be used in the development of the newest electronic materials and thermoelectrics which need high-performance properties. A similar trend occurred after we established the fact that the temperature-induced changes have a strong effect on electron occupancy and the Fisher's z-distribution proves its potential to predict the high-energy tail behavior. The next illustration discovered that not only higher charge carrier fluctuations lead to an increase in conductivity but when they become very extreme, they can cause instability in the transport of charge carriers. Finally, the tesimprovedtsairy shorty rich teils Licensee isle It is so because Fisher's z-distribution provides more versatile representation of charge carrier statistics than Gaussian and Fermi-Dirac models but one is most needed when shopping in the extremes between electronic transport.

Future research should address the experimental validation of the Fisher's z-distribution in semiconductor materials as well as electron transition and multi-carrier interaction. By employing this statistical model in semiconductors, one would indeed be able to come up with electronics materials that are more efficient and optoelectronic which would advance high-speed transistors, thermoelectric generators as well as the next generation of semiconductor technologies.

REFERENCES

[1] S. Shihab, M. Rasheed, O. Alabdali, and A. A. Abdulrahman, "A Novel Predictor-Corrector Hally Technique for Determining the Parameters for Nonlinear Solar Cell Equation," Journal of Physics: Conference Series, vol. 1879, no. 2, p. 022120, May 2021, doi: https://doi.org/10.1088/1742-6596/1879/2/022120.
[2] Aasim Jasim Hussein, Mustafa Nuhad Al-Darraji, M. Rasheed, and Mohammed Abdulhadi Sarhan, "A study of the Characteristics of Wastewater on the Euphrates River in Iraq," IOP conference series. Earth and environmental science, vol. 1262, no. 2, pp. 022005–022005, Dec. 2023, doi: https://doi.org/10.1088/1755-1315/1262/2/022005.
[3] Ahcen Keziz, M. Heraiz, F. Sahnoune, and M. Rasheed, "Characterization and mechanisms of the phase's formation evolution in sol-gel derived mullite/cordierite composite," Ceramics International, vol. 49, no. 20, pp. 32989–33003, Oct. 2023, doi: https://doi.org/10.1016/j.ceramint.2023.07.275.
[4] D. Bouras, M. Rasheed, R. Barille, and M. N. Aldaraji, "Efficiency of adding DD3+(Li/Mg) composite to plants and their fibers during the process of filtering solutions of toxic organic dyes," Optical Materials, vol. 131, p. 112725, Sep. 2022, doi: https://doi.org/10.1016/j.optmat.2022.112725.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

[5] Manel Sellam, M. Rasheed, S. Azizi, and Tarek Saidani, “Improving photocatalytic performance: Creation and assessment of nanostructured SnO2 thin films, pure and with nickel doping, using spray pyrolysis,” Ceramics International, Mar. 2024, doi: https://doi.org/10.1016/j.ceramint.2024.03.094.

[6] E. Kadri, K. Dhahri, R. Barillé, and M. Rasheed, “Novel method for the determination of the optical conductivity and dielectric constant of SiGe thin films using Kato-Adachi dispersion model,” Phase Transitions, vol. 94, no. 2, pp. 65–76, Feb. 2021, doi: https://doi.org/10.1080/01411594.2020.1832224.

[7] Ahcen Keziz, M. Rasheed, M. Heraiz, F. Sahnoune, and A. Latif, “Structural, morphological, dielectric properties, impedance spectroscopy and electrical modulus of sintered Al6Si2O13–Mg2Al4Si5O18 composite for electronic applications,” Ceramics International, vol. 49, no. 23, pp. 37423–37434, Dec. 2023, doi: https://doi.org/10.1016/j.ceramint.2023.09.068.

[8] I. Alshalal, H. M. I. Al-Zuhairi, A. A. Abtan, M. Rasheed, and M. K. Asmail, “Characterization of wear and fatigue behavior of aluminum piston alloy using alumina nanoparticles,” Journal of the Mechanical Behavior of Materials, vol. 32, no. 1, Jan. 2023, doi: https://doi.org/10.1515/jmbm-2022-0280.

[9] M. Al-Darraji, S. Jasim, O. Salah Aldeen, A. Ghasemian, and M. Rasheed, “The Effect of LL37 Antimicrobial Peptide on FOXE1 and lncRNA PTCSC 2 Genes Expression in Colorectal Cancer (CRC) and Normal Cells,” Asian Pacific Journal of Cancer Prevention, vol. 23, no. 10, pp. 3437–3442, Oct. 2022, doi: https://doi.org/10.31557/apjcp.2022.23.10.3437.

[10] Ruqaya Shaker Mahmood, "Applications of the Difference of Successes Continuous Distribution in Modeling Variability Between Dependent Success Rates", Journal of Positive Sciences, Vol. 4, Issue: 1, pp: 38-46, (2024). doi: https://doi.org/10.52688/ASP80026.

[11] Ruqaya Shaker Mahmood, "Exploring the Application of Doob's Theorem Distribution in Stochastic Process Analysis for System Reliability and Performance Evaluation", Journal of Positive Sciences, Vol. 4, Issue: 3, pp: 44-52, (2024). doi: https://doi.org/10.52688/ASP80026.

[12] Ruqaya Shaker Mahmood, "Multivariate Statistical Modeling and Dependence Structures using Copula Distributions", Journal of Positive Sciences, Vol. 3, Issue: 5, pp: 56-63, (2023). doi: https://doi.org/10.52688/ASP80026.

[13] Ruqaya Shaker Mahmood, Rana Jamal Mizban, Mohammed Abdulhadi Sarhan, Ahmed Rashid, Mohammed RASHEED, Tarek Saidani, "Analysis Of Correlated Random Variables Using Bivariate Normal Distribution: Numerical Examples And Applications", Journal of Positive Sciences, Vol. 4, Issue: 1, pp: 28-37, (2024). doi: https://doi.org/10.52688/ASP39921.

[14] Ruqaya Shaker Mahmood, Rana Jamal Mizban, Mohammed Abdulhadi Sarhan, Ahmed Rashid, Mohammed RASHEED, Tarek Saidani, "Analysis And Applications Of The Beta Prime Distribution In Statistical Modeling", Journal of Positive Sciences, Vol. 3, Issue: 6, pp: 34-41, (2023). doi: https://doi.org/10.52688/ASP61622.

[15] Ruqaya Shaker Mahmood, Rana Jamal Mizban, Mohammed Abdulhadi Sarhan, Ahmed Rashid, Mohammed RASHEED, Tarek Saidani, "Utilizing Beta Distribution For Probabilistic Modeling: Five Numerical Examples", Journal of Positive Sciences, Vol: 3, Issue: 5, pp: 40-48, (2023). doi: https://doi.org/10.52688/ASP42440.

[16] Ahmed Shawki Jaber, Mohammed Abdulhadi Sarhan, Rana Jamal Mizban, Ahmed Rashid, Mohammed RASHEED, Ruqaya Shaker Mahmood, Tarek Diab Ounis, "Modeling Event Occurrences Using the Borel-Tanner Distribution: Applications and Numerical Analysis", Journal of Positive Sciences, Vol.: 3, Issue: 5, pp: 49-55, (2024). doi: https://doi.org/10.52688/ASP31971.

[17] Ahmed Shawki Jaber, Taha Rashid, Mohammed RASHEED, Ruqaya Shaker Mahmood, Olfa Maalej, "Analysis of Cauchy Distribution and Its Applications", Journal of Positive Sciences, Vol. 4, Issue: 4, pp: 21-27, (2024). doi: https://doi.org/10.52688/ASP54542.

[18] Ahmed Shukur, Ahmed Shawki Jaber, Ahmed Rashid, Mohammed RASHEED, Ruqaya Shaker Mahmood, Tarek Diab Ounis, "Application of Bose-Einstein Distribution in Quantum Systems and Statistical Mechanics", Journal of Positive Sciences, Vol. 4, Issue: 2, pp: 27-36, (2024). doi: https://doi.org/10.52688/ASP27315.

[19] Ahmed Shukur, Ahmed Shawki Jaber, Ahmed Rashid, Mohammed RASHEED, Ruqaya Shaker Mahmood, Tarek Diab Ounis, "Application of the Box-Muller Transformation in Generating Normally Distributed Random Variables: A Numerical Approach", Journal of Positive Sciences, Vol. 4, Issue: 3, pp: 32-43, (2024). doi: https://doi.org/10.52688/ASP82349.

[20] M. Rasheed, O. Y. Mohammed, S. Shihab, and A. Al-Adili, “Explicit Numerical Model of Solar Cells to Determine Current and Voltage,” Journal of Physics: Conference Series, vol. 1795, no. 1, p. 012043, Mar. 2021, doi: https://doi.org/10.1088/1742-6596/1795/1/012043.

[21] M. Rasheed, S. Shihab, O. Y. Mohammed, and A. Al-Adili, “Parameters Estimation of Photovoltaic Model Using Nonlinear Algorithms,” Journal of Physics: Conference Series, vol. 1795, no. 1, p. 012058, Mar. 2021, doi: https://doi.org/10.1088/1742-6596/1795/1/012058.

[22] M. A. Sarhan, S. Shihab, B. E. Kashem, and M. Rasheed, “New Exact Operational Shifted Pell Matrices and Their Application in Astrophysics,” Journal of Physics: Conference Series, vol. 1879, no. 2, p. 022122, May 2021, doi: https://doi.org/10.1088/1742-6596/1879/2/022122.

[23] O. Alabdali, S. Shihab, M. Rasheed, and T. Rashid, “Orthogonal Boubaker-Turki polynomials algorithm for problems arising in engineering,” 3RD INTERNATIONAL SCIENTIFIC CONFERENCE OF ALKAFEEL UNIVERSITY (ISCKU 2021), 2022, doi: https://doi.org/10.1063/5.0066860.

[24] M. Darraji, L. Saqban, T. Mutar, M. Rasheed, and A. Hussein, “Association of Candidate Genes Polymorphisms in Iraqi Patients with Chronic Kidney Disease,” Journal of Advanced Biotechnology and Experimental Therapeutics, vol. 6, no. 1, p. 687, 2022, doi: https://doi.org/10.5455/jabet.2022.d147.

[25] D. Bouras, Mamoun Fellah, Régis Barille, Mohammed Abdul Samad, M. Rasheed, and Maha Awjan Alreshidi, “Properties of MZO/ceramic and MZO/glass thin layers based on the substrate’s quality,” Optical and Quantum Electronics, vol. 56, no. 1, Dec. 2023, doi: https://doi.org/10.1007/s11082-023-05778-6.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

[26] A. Jaber, M. Ismael, T. Rashid, Mohammed Abdulhadi Sarhan, M. Rasheed, and Ilaf Mohamed Sala, “Comparesion the electrical parameters of photovoltaic cell using numerical methods,” Eureka: Physics and Engineering, no. 4, pp. 29–39, Jul. 2023, doi: https://doi.org/10.21303/2461-4262.2023.002770.

[27] Taha Rashid, Mohammed Abdulhadi Sarhan, Ahmed Shukur, Mohammed RASHEED, Ruqaya Shaker Mahmood, Olfa Maalej, "Applications of Chi-Squared Distribution in Hypothesis Testing and Random Variable Analysis", Journal of Positive Sciences, Vol. 4, Issue: 4, pp: 36-45, (2024). doi: https://doi.org/10.52688/ASP 11655.

[28] Taha Rashid, Ahmed Shukur, Mohammed RASHEED, Ruqaya Shaker Mahmood, Olfa Maalej, "Application of the Chi Distribution in Statistical Modeling and Simulation: Numerical Examples and Analysis", Journal of Positive Sciences, Vol. 4, Issue: 4, pp: 28-35, (2024). doi: https://doi.org/10.52688/ASP24189.

[29] Mohammed Abdulhadi Sarhan, Mohammed RASHEED, Ruqaya Shaker Mahmood, Taha Rashid, Olfa Maalej, "Evaluating the Effectiveness of Continuity Correction in Discrete Probability Distributions", Journal of Positive Sciences, Vol. 4, Issue: 4, pp: 46-54, (2024). doi: https://doi.org/10.52688/ASP66811.

[30] D. Bouras and M. Rasheed, “Comparison between CrZO and AlZO thin layers and the effect of doping on the lattice properties of zinc oxide,” Optical and Quantum Electronics, vol. 54, no. 12, Oct. 2022, doi: https://doi.org/10.1007/s11082-022-04161-1.

[31] N. Assoudi et al., “Comparative examination of the physical parameters of the sol gel produced compounds La0.5Ag0.1Ca0.4MnO3 and La0.6Ca0.3Ag0.1MnO3,” Optical and Quantum Electronics, vol. 54, no. 9, Jul. 2022, doi: https://doi.org/10.1007/s11082-022-03927-x.

[32] M. Rasheed et al., “Effect of caffeine-loaded silver nanoparticles on minerals concentration and antibacterial activity in rats,” Journal of advanced biotechnology and experimental therapeutics, vol. 6, no. 2, pp. 495–495, Jan. 2023, doi: https://doi.org/10.5455/jabet.2023.d144.

[33] Farouk BOUDOU, Abdelmadjid GUENDOUZI, A. BELKREDAR, and M. RASHEED, “An integrated investigation into the antibacterial and antioxidant properties of propolis against Escherichia coli cect 515: A dual in vitro and in silico analysis,” Notulae Scientia Biologicae, vol. 16, no. 2, pp. 13837–13837, May 2024, doi: https://doi.org/10.55779/nsb16211837.

[34] D. Bouras, M. Fellah, A. Mecif, R. Barillé, A. Obrosov, and M. Rasheed, “High photocatalytic capacity of porous ceramic-based powder doped with MgO,” Journal of the Korean Ceramic Society, Oct. 2022, doi: https://doi.org/10.1007/s43207-022-00254-5.

[35] T. Rashid, Musa Mohd Mokji, and M. Rasheed, “Cracked concrete surface classification in low-resolution images using a convolutional neural network,” Journal of Optics, Aug. 2024, doi: https://doi.org/10.1007/s12596-024-02080-w.

[36] Aasim Jasim Hussein, Mustafa Nuhad Al-Darraji, and M. Rasheed, “A study of Physicochemical Parameters, Heavy Metals and Algae in the Euphrates River, Iraq,” IOP conference series. Earth and environmental science, vol. 1262, no. 2, pp. 022007–022007, Dec. 2023, doi: https://doi.org/10.1088/1755-1315/1262/2/022007.

[37] H. K. Aity, E. Dhahri, and M. Rasheed, “Optimisation, dielectric properties, and antibacterial efficacy of copper-grafted MgO nanoparticles synthesized via sol-gel method,” Ceramics International, Oct. 2024, doi: https://doi.org/10.1016/j.ceramint.2024.10.324.

[38] Ahmed Shawki Jaber, M. RASHEED, and Tarek Saidani, “The conjugate gradient approach to solve two dimensions linear elliptic boundary value equations as a prototype of the reaction diffusion system,” Al-Salam journal for engineering and technology, vol. 3, no. 1, pp. 157–168, Jan. 2024, doi: https://doi.org/10.55145/ajest.2024.03.01.014.

[39] Selma, M. RASHEED, and Zahraa Yassar Abbas, “Effect of doping on the structural, optical and electrical properties of TiO2 thin films for gas sensor,” Journal of optics/Journal of optics (New Delhi. Print), May 2024, doi: https://doi.org/10.1007/s12596-024-01913-y.

[40] M. Enneffatia, M. Rasheed, B. Louatia, K. Guidaraa, S. Shihab, and R. Barillé, “Investigation of structural, morphology, optical properties and electrical transport conduction of Li0.25Na0.75CdVO4 compound,” Journal of Physics: Conference Series, vol. 1795, no. 1, p. 012050, Mar. 2021, doi: https://doi.org/10.1088/1742-6596/1795/1/012050.

[41] M. Rasheed, M. N. Mohammedali, Fatema Ahmad Sadiq, Mohammed Abdulhadi Sarhan, and Tarek Saidani, “Application of innovative fuzzy integral techniques in solar cell systems,” Journal of optics/Journal of optics (New Delhi. Print), Jun. 2024, doi: https://doi.org/10.1007/s12596-024-01928-5.

[42] A. Zubaidi, Lamyaa Mahdi Asaad, Iqbal Alshalal, and M. Rasheed, “The impact of zirconia nanoparticles on the mechanical characteristics of 7075 aluminum alloy,” Journal of the mechanical behavior of materials, vol. 32, no. 1, Jan. 2023, doi: https://doi.org/10.1515/jmbm-2022-0302.

[43] Ahmed Shukur, "Application of Error Continuous Distribution in Analyzing Systematic Variability across Engineering Processes", Journal of Positive Sciences, Vol. 4, Issue: 1, pp: 47-54, (2024). doi: https://doi.org/10.52688/ASP58911.

[44] Ahmed Shukur, " Application of Error Function Continuous Distribution in Predictive Modeling and Quality Control", Journal of Positive Sciences, Vol. 4, Issue: 3, pp: 53-61, (2024). doi: https://doi.org/10.52688/ASP84163.

[45] Mohammed RASHEED, "Analyzing Applications and Properties of the Exponential Continuous Distribution in Reliability and Survival Analysis", Journal of Positive Sciences, Vol. 4, Issue: 5, pp: 71-79, (2023). doi: https://doi.org/10.52688/ASP30767.

[46] Mohammed RASHEED, "Modeling and Analysis of Extreme Events using Extreme Value Continuous Distribution", Journal of Positive Sciences, Vol. 4, Issue: 1, pp: 55-63, (2024). doi: https://doi.org/10.52688/ASP37713.

[47] Ahmed Shukur, "Sequential Event Modeling and Reliability Analysis using the Erlang Continuous Distribution", Journal of Positive Sciences, Vol. 3, Issue: 5, pp: 64-70, (2023). doi: https://doi.org/10.52688/ASP85431.

[48] Djelel Kherifi, Ahcen Keziz, M. Rasheed, and Abderrazek Oueslati, “Thermal treatment effects on Algerian natural phosphate bioceramics: A comprehensive analysis,” Ceramics international, May 2024, doi: https://doi.org/10.1016/j.ceramint.2024.05.317.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

[49] A. Shukur, Ahmed Shawki Jaber, M. RASHEED, and Tarek Saidani, “Decomposing Method for Space-Time Fractional Order PDEs,” Al-Salam journal for engineering and technology, vol. 3, no. 2, pp. 1–11, May 2024, doi: https://doi.org/10.55145/ajest.2024.03.02.01.

[50] Ahcen Keziz, Meand Heraiz, M. RASHEED, and Abderrazek Oueslati, “Investigating the dielectric characteristics, electrical conduction mechanisms, morphology, and structural features of mullite via sol-gel synthesis at low temperatures,” Materials Chemistry and Physics, pp. 129757–129757, Jul. 2024, doi: https://doi.org/10.1016/j.matchemphys.2024.129757.

[51] A. Raghdi, Menad Heraiz, M. Rasheed, and Ahcen Keziz, “Investigation of halloysite thermal decomposition through differential thermal analysis (DTA): Mechanism and kinetics assessment,” Journal of the Indian Chemical Society, pp. 101413–101413, Oct. 2024, doi: https://doi.org/10.1016/j.jics.2024.101413.

[52] W. Saidi, Nasreddine Hfaidh, M. Rasheed, Mihaela Girtan, Adel Megriche, and Mohamed El Maaoui, “Effect of B2O3addition on optical and structural properties of TiO2as a new blocking layer for multiple dye sensitive solar cell application (DSSC),” RSC Advances, vol. 6, no. 73, pp. 68819–68826, Jan. 2016, doi: https://doi.org/10.1039/c6ra15060h.

[53] M. Rasheed, SuhaShihab, O. Alabdali, and H. H. Hassan, “Parameters Extraction of a Single-Diode Model of Photovoltaic Cell Using False Position Iterative Method,” Journal of Physics: Conference Series, vol. 1879, no. 3, p. 032113, May 2021, doi: https://doi.org/10.1088/1742-6596/1879/3/032113.

[54] M. Rasheed, S. Shihab, O. Alabdali, A. Rashid, and T. Rashid, “Finding Roots of Nonlinear Equation for Optoelectronic Device,” Journal of Physics: Conference Series, vol. 1999, no. 1, p. 012077, Sep. 2021, doi: https://doi.org/10.1088/1742-6596/1999/1/012077.

[55] M. Rasheed, O. Alabdali, S. Shihab, A. Rashid, and T. Rashid, “On the Solution of Nonlinear Equation for Photovoltaic Cell Using New Iterative Algorithms,” Journal of Physics: Conference Series, vol. 1999, no. 1, p. 012078, Sep. 2021, doi: https://doi.org/10.1088/1742-6596/1999/1/012078.

[56] Mohammed Rasheed, Ahmed Jabber, Mohammed Sarhan, Tarek Saidani, Mustafa Al-darraji, Two mathematical models for solving the photovoltaic cell's nonlinear formula, Journal of New Technology and Materials, vol. 13, Issue. 1, pp: 17-24 (2023).

[57] Habiba K. Aity, Esra A. Hashem, Mohammed RASHEED, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Olfa Maalej, "The role of optical properties in enhancing antimicrobial activity of Mg0.94Cu0.06O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 12-22, (2024). doi: https://doi.org/10.52688/ASP19241.

[58] Areej Adnan Hateef, Essebti Dhahri, M. Rasheed, Habiba Kadhim, Z. Abbas, and N. Hassan, “Study of the influence concentration difference of copper in properties of cerium nanopowder,” *Physics and Chemistry of Solid State*, vol. 25, no. 4, pp. 801–810, (2024), doi: https://doi.org/10.15330/pcss.25.4.801-810.

[59] Mohammed RASHEED, Habiba K. Aity, Ketam K. Khudair, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Taha Rashid, "The influence of structural properties on antibacterial potential of Mg0.95Fe0.03O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 64-74, (2024). doi: https://doi.org/10.52688/ASP50513.

[60] Ketam K. Khudair, Habiba K. Aity, Ruqaya Shaker Mahmood, Mohammed RASHEED, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Taha Rashid, "Optical analysis and its impact on antibacterial performance of Mg0.97Fe0.03O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 75-86, (2024). doi: https://doi.org/10.52688/ASP88399.

[61] Rafal A. Obayed, Habiba K. Aity, Ruqaya Shaker Mahmood, Mohammed RASHEED, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Taha Rashid, "Investigating structural traits and their role in antibacterial properties of Mg0.94Fe0.06O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 87-96, (2024). doi: https://doi.org/10.52688/ASP75220.

[62] Habiba K. Aity, Kawther A. Alameri, Mohammed RASHEED, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Olfa Maalej, "The effect of structure on antibacterial performance of Mg0.94Cu0.06O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 1-11, (2024). doi: https://doi.org/10.52688/ASP441661.

[63] Mohammed RASHEED, Ketam K. Khudair, Habiba K. Aity, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Taha Rashid, "The impact of optical characteristics on antibacterial properties of Mg0.99Fe0.01O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 54-63, (2024). doi: https://doi.org/10.52688/ASP75371.

[64] E. Kadri, M. Krichen, R. Mohammed, A. Zouari, and K. Khirouni, “Electrical transport mechanisms in amorphous silicon/crystalline silicon germanium heterojunction solar cell: impact of passivation layer in conversion efficiency,” Optical and Quantum Electronics, vol. 48, no. 12, Nov. 2016, doi: https://doi.org/10.1007/s11082-016-0812-7.

[65] M. Rasheed, M. N. Al-Darraji, S. Shihab, A. Rashid, and T. Rashid, “Solar PV Modelling and Parameter Extraction Using Iterative Algorithms,” Journal of Physics: Conference Series, vol. 1963, no. 1, p. 012059, Jul. 2021, doi: https://doi.org/10.1088/1742-6596/1963/1/012059.

[66] M. Rasheed, M. Nuhad Al-Darraji, S. Shihab, A. Rashid, and T. Rashid, “The numerical Calculations of Single-Diode Solar Cell Modeling Parameters,” Journal of Physics: Conference Series, vol. 1963, no. 1, p. 012058, Jul. 2021, doi: https://doi.org/10.1088/1742-6596/1963/1/012058.

[67] Habiba K. Aity, Mohammed RASHEED, Kawther A. Alameri, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Marwa Enneffati, "Structural properties and bacterial inhibition capabilities of Mg0.91Cu0.09O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 23-33, (2024). doi: https://doi.org/10.52688/ASP28610.

[68] Habiba K. Aity, Mohammed RASHEED, Esra A. Hashem, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Marwa Enneffati, "Assessing Optical Behavior and Antibacterial Potency of Mg0.91Cu0.09O Nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 6, pp: 34-43, (2024). doi: https://doi.org/10.52688/ASP80838.

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

[69] Habiba K. Aity, Muwafaq A. Hasan, Mohammed RASHEED, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Haider s. Mohammed, Mohammed H. Ali, Sammah Dammaka, Radhia Dhahri, Ahmed RASHID, Tarek Saidani, "Evaluating structural properties and antibacterial activity of MgxCu1-xO nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 5, pp: 9-19, (2024). doi: https://doi.org/10.52688/ASP72524.

[70] Habiba K. Aity, Rana A. Hadi, Ruqaya Shaker Mahmood, Mohammed RASHEED, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Ahmed RASHID, Nareman Chakchouk, "The relationship between optical characteristics and antibacterial performance of Mg0.97Cu0.03O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 5, pp: 30-40, (2024). doi: https://doi.org/10.52688/ASP33167.

[71] Habiba K. Aity, Rana A. Hadi, Mohammed RASHEED, Ruqaya Shaker Mahmood, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Haider s. Mohammed, Mohammed H. Ali, Sammah Dammaka, Radhia Dhahri, Ahmed RASHID, Tarek Saidani, "Optical behavior and its role in the antimicrobial properties of MgxCu1-xO nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 5, pp: 20-29, (2024). doi: https://doi.org/10.52688/ASP66329.

[72] Habiba K. Aity, Ruqaya Shaker Mahmood, Muwafaq A. Hasan, Mohammed RASHEED, Farqad A. Rashid, Zahraa Abbas, Areej A. Hateef, Haider s. Mohammed, Mohammed H. Ali, Sammah Dammaka, Radhia Dhahri, Ahmed RASHID, Nareman Chakchouk, "Exploring the structural features and antimicrobial functionality of Mg0.95Cu0.05O nanoparticles", Journal of Positive Sciences, Vol. 4, Issue: 5, pp: 30-40, (2024). doi: https://doi.org/10.52688/ASP57261.

[73] A Jaber, Taha Rashid, Mohammed Rasheed, Ruqaya Shaker Mahmood, Olfa Maalej, Analysis of Cauchy Distribution and Its Applications, Journal of Positive Sciences, vol. 4, Issue 4, (2024). doi: https://doi.org/10.52688/ASP54542.

[74] Abbas MM, Rasheed M. Investigation of structural, Mechanical, Thermal and Optical Properties of Cu Doped TiO2. Iraqi Journal of Physics. 2021 Mar 1;19(48):1-9. doi: https://doi.org/10.30723/ijp.v19i48.615.

[75] Abdul-jabbar, A., Rashid, T., RASHEED, M., Sarhan, M., Jaber, A., Aldaraji, M., Saidani, T., & Rashid, A. An NMOS transistor-based high-gain operational amplifier designed in 0.25-micron CMOS technology. *Al-Salam Journal for Engineering and Technology*, *2*(1), 123–133. (2023). doi: https://doi.org/10.55145/ajest.2023.01.01.015.

[76] Adil K Bagheedh ,Adil K Bagheedh, Ahmed Shukur, Ahmed Shawki Jaber, Mohammed Abdulhadi Sarhan, "Impact Of Fractional Order On Chaos: Numerical Simulation Of A Fractional Logistic Map", Journal of Positive Sciences, vol. 4. issue. 3. pp: 15-24. (2024). doi: https://doi.org/10.52688/ASP81801.

[77] Alabdali, Osama, Guessab, Allal, Sharp multidimensional numerical integration for strongly convex functions on convex polytopes, Filomat, Universitet of Nis, Volume 34, Issue 2, Pages 601 – 607, 2020. https://doi.org/10.2298/FIL2002601A.

[78] Aldaraji, M., Al-Azzawi, T., RASHEED, M., Sarhan, M., Jaber, A., Saidani, T., & Rashid, T. (2023). Investigating the effect of consuming soft drinks on the liver and kidney functions of a sample from the Iraqi community. *Al-Salam Journal for Engineering and Technology*, *2*(1), 103–108. doi: https://doi.org/10.55145/ajest.2023.01.01.0012.

[79] Aldaraji, M., Al-Azzawi, T., RASHEED, M., Sarhan, M., Jaber, A., Saidani, T., & Rashid, T. (2023). Investigating the effect of consuming soft drinks on the liver and kidney functions of a sample from the Iraqi community. *Al-Salam Journal for Engineering and Technology*, *2*(1), 103–108. doi: https://doi.org/10.55145/ajest.2023.01.01.0012.

[80] Ali Hasan Ali, Osama Alabdali, Mustafa T Yaseen, Maryam Al-Kandari, Omar Bazighifan, A new modification of an iterative method based on inverse polynomial for solving Cauchy problems, Arab Journal of Basic and Applied Sciences, Taylor & Francis, Volume 30, Issue 1, 2023, Pages 393-400. https://doi.org/10.1080/25765299.2023.2228054.

[81] Ashraf, Rashid, Nawaz, Rashid, Alabdali, Osama, Fewster-Young, Nicholas, Ali, Ali Hasan, Ghanim, Firas, Alb Lupaş, Alina, A New Hybrid Optimal Auxiliary Function Method for Approximate Solutions of Non-Linear Fractional Partial Differential Equations, Fractal and Fractional, Multidisciplinary Digital Publishing Institute (MDPI), Fractal Fract. 2023, 7(9), 673. https://doi.org/10.3390/fractalfract7090673.

[82] Hussein AM, Abdullah SA, RASHEED M, Zamel RS. Optical and electrical properties of glass/graphene oxide thin films. Iraqi Journal of Physics. 2020 Dec 1;18(47):73-83. https://doi.org/10.30723/ijp.v18i47.617.

[83] Jaber, A., Sarhan, M., Al-Darraji, M., RASHEED, M., Saidani, T., Rashid, T., & Rashid, A. (2023). A study of the physiological disorders of slimming drugs on people who abuse them. *Al-Salam Journal for Medical Science*, *2*(1), 21–27. doi: https://doi.org/10.55145/ajbms. 2023.1.1.004.

[84] M. A. Sarhan, S. SHIHAB, and M. RASHEED, "A Novel Spectral Modified Pell Polynomials for Solving Singular Differential Equations", *Al-Mustansiriyah J. Sci.*, vol. 32, no. 1, pp. 18–24, Feb. 2021, doi: 10.23851/mjs.v32i1.930.

[85] Mimoon Ismael, Saba Hat, Osama Alabdali, Showkat Ahmad Lone, Ali Hasan Ali, Partial Differential Equations in Applied Mathematics, Modified optimal auxiliary functions method for approximate-analytical solutions in fractional order nonlinear Foam Drainage equations, Elsevier, Volume 10, June 2024, 100700. https://doi.org/10.1016/j.padiff.2024.100700.

[86] Mohammed RASHEED, Mohammed Abdelhadi Sarhan, Ahmed Shawki Jaber, Dikra Bouras, Mustafa Nuhad Al-Darraji, Ahmed Rashid. (2022). Statistical Analysis of Copper Doped Titanium Dioxide. *Journal of Al-Qadisiyah for Computer Science and Mathematics*, *14*(3), Math Page 80–88. doi: https://doi.org/10.29304/jqcm.2022.14.3.1030.

[87] Mohammed Rasheed, Regis Barille, Development and characterization of single and multilayer thin films for optoelectronics application, Ph. D. Thesis University of Angers, (2017).

[88] Mohammed RASHEED, Nouman Oubeid, "Statistical Modeling and Analysis Using F-Ratio Continuous Distribution", Journal of Positive Sciences, Vol. 5, Issue: 1, pp: 38-48, (2025). doi: https://doi.org/10.52688/ASP25045.

[89] Mostafa Bachar, Allal Guessab, Osama Mohammed, Yassine Zaim, New cubature formulas and Hermite–Hadamard type inequalities using integrals over some hyperplanes in the d-dimensional hyper-rectangle, Applied Mathematics and Computation, 315, 2017: 347-362. http://dx.doi.org/10.1016/j.amc.2017.07.083.

[90] Osama Alabdali, Allal Guessab, Optimal estimates of approximation errors for strongly positive linear operators on convex polytopes, Filomat, Universitet of Nis, Volume 36, Issue 2, Pages 695-701, 2022. https://doi.org/10.2298/FIL2202695A

---

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com

[91] Osama Yousif Mohammed Alabdali, Allal Guessab, On the approximation of strongly convex functions by an upper or lower operator, Applied Mathematics and Computation, 247, 2014: 1129-1138. https://doi.org/10.1016/j.amc.2014.09.007.

[92] RASHEED, M., Majeed, S., Alabdali, O., Abbood, M., & Ounis, T. (2023). Preparation and Characterization of Nickel Oxide for Antibacterial Properties: Nickel Oxide for Antibacterial Properties. *Al-Salam Journal for Engineering and Technology*, *2*(1), 117–122. doi: https://doi.org/10.55145/ajest.2023.01.01.0014.

[93] RASHEED, M., Rashid, T., bin Hamzah, M. N., Jaber, A. S., Sarhan, M. A., Aldaraji, M. N., Saidani, T., & Rashid, A. . (2023). Design A Combinational Circuit Consists of 10 Logic Gates Using Quartos. *Al-Salam Journal for Engineering and Technology*, *2*(1), 85–93. doi: https://doi.org/10.55145/ajest.2023.01.01.0010.

[94] RASHEED, M., Sarhan, M. A., Jaber, A. S., Bouras, D., Al-Darraji, M. N., & Rashid, A. (2022). Statistical Analysis of Aluminum Doped Titanium Dioxide Using Solid State Method: Statistical Analysis. *Journal of Al-Qadisiyah for Computer Science and Mathematics*, *14*(3), Math Page 1–8. doi: https://doi.org/10.29304/jqcm.2022.14.3.955.

[95] RASHEED, M., Rashid, A., Rashid, T., Abed Hamed, S. H., & Sabri, A. A. (2021). Analysis of Non-Linear Device by means of Numerical Algorithms. *Journal of Al-Qadisiyah for Computer Science and Mathematics*, *13*(3), Math Page 79– 87. doi: https://doi.org/10.29304/jqcm.2021.13.3.845.

[96] RASHEED, M., Rashid, A., Rashid, T., Abed Hamed, S. H., & Manoochehr, N. T. (2021). Various Numerical Methods for Solving Nonlinear Equation. *Journal of Al-Qadisiyah for Computer Science and Mathematics*, *13*(3), Math Page 88– 97. doi: https://doi.org/10.29304/jqcm.2021.13.3.846.

[97] RASHEED, M., SHIHAB, S., RASHID, T., & Ounis, T. D. (2021). Determination of PV Model Parameters Using Bisection and Secant Methods. *Journal of Al-Qadisiyah for Computer Science and Mathematics*, *13*(1), Math Page 43– 54. doi: https://doi.org/10.29304/jqcm.2021.13.1.744.

[98] Rasheed MS, Mohammed AN. Design of a laser based free space communication system. LAP LAMBERT Academic Publishing; 2012 Oct 20.

[99] Rashid, T., RASHEED, M., Sarhan, M. A. ., Jaber, A. S. ., Aldaraji, M. N. ., Saidani, T., & Rashid, A. . (2023). Folded Cascode Operational Amplifier Design Utilizing 0.25 µm CMOS Technology . *Al-Salam Journal for Engineering and Technology*, *2*(1), 76–84. doi: https://doi.org/10.55145/ajest.2023.01.01.009.

[100] Rashid, T., RASHEED, M., Sarhan, M., Jaber, A., Aldaraji, M., Saidani, T., & Anwar Abdul-jabbar, A. (2022). A study of MOSFET Device for The characterization of ID-VG and ID-VD Curves. *Al-Salam Journal for Engineering and Technology*, *2*(1), 40–45. doi: https://doi.org/10.55145/ajest.2023.01.01.005.

[101] Saidani T, Rasheed M, Alshalal I, Rashed AA, Sarhan MA, Barille R, Saidani T, Rasheed M, Alshalal I, Rashed AA, Sarhan MA. Characterization of thin ITO/Au/ITO sandwich films deposited on glass substrates using DC magnetron sputtering. doi: Res. Eng. Struct. Mater. vol. 10, no. 2: pp: 743-770. (2024). doi: https://doi.org/10.17515/resm2023.21ma0922rs.

[102] SHIHAB, S., RASHEED, M., Rashid, A., Rashid, T., Abed Hamed, S. H., & Manoochehr, N. T. (2021). An Accelerated Algorithm for Finding Roots of Nonlinear Equation. *Journal of Al-Qadisiyah for Computer Science and Mathematics*, *13*(2), Math Page 160– 168. doi: https://doi.org/10.29304/jqcm.2021.13.2.811.

[103] Taha Rashid, Muhammad bin Hamzah, MOHAMMED RASHEED, Ahmed Jaber, Mohammed Sarhan, Mustafa Aldaraji, Tarek Saidani, Image segmentation for animals in the wild using scilab software. Al-Salam Journal for Engineering and Technology, vol. 2, Issue 2, pp: 72-77. (2023). doi: https://doi.org/10.55145/ajest.2023.02.02.009.

[104] Osama Alabdali, Mohammed Abdulhadi Sarhan, Humam A. Abdulrazzaq, Mohammed RASHEED, "Improvement of electronics properties electronically via the Fermi-Dirac continuous distribution", Journal of Positive Sciences, Vol. 5, Issue: 2, pp: 7-19, (2025). doi: https://doi.org/10.52688/ASP79312.

[105] Osama Alabdali, Humam A. Abdulrazzaq, Mohammed Abdulhadi Sarhan, Mohammed RASHEED, "Optimization of electronic transport properties using the Fisher-Tippett continuous distribution", Journal of Positive Sciences, Vol. 5, Issue: 2, pp: 20-40, (2025). doi: https://doi.org/10.52688/ASP74993.

*Corresponding author
Rana Jamal Mizban,
Department of Mechanical Engineering, University of Technology- Iraq, Baghdad, Iraq
e-mail: ranajamall700@gmail.com