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Numerical Simulation of Photovoltaic Cell

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ABSTRACT

In this paper, we established some mathematical methods in order to solve real zeroes of nonlinear equation for a single diode model for a PV cell without second derivatives for the function using Improved Double False Position method as called (Illinois algorithm) which is mainly due to some scholars and Ford (1995). We applied the new proposed method with two-step iterative method to solve test example in order to assess their validity and accuracy. The results obtained reveals that the modified method is accurate and efficient with a lesser number of iterations compared with the other standard methods such as NRM.

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1. Introduction

Improved Double False Position method is a root-finding algorithm; during the last few years, the numerical analysis for solving nonlinear equations has been successfully utilized. There are many articles concern with a nonlinear equation in the field of Engineering and Sciences have been achieved. Many root-finding algorithms can be utilized to acquire approximations to such a root. One of the most popular algorithms is Newton's method; it did not require second derivatives functions. Only iterative numerical algorithms can solve many nonlinear equations,

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involving most of the more complicated ones [1-39]. All the numerical methods need a rough approximate value of a given equation root to enable it to generate sequential initial values of a given equation root to enable it to generate a sequential of better approximate values for that root. Several techniques improved on the perfection of convergence for Newton's algorithm, for obtaining minimum iterations [40-66].

In this paper, some new technique (Illinois algorithm) based on NRM are introduced and analyzed for solving real zeroes of nonlinear equation of a photovoltaic cell. The procedure of the present work is: section two describes the non-linear equation; section three investigates the zero finding of Newton Raphson algorithm; while in section four Improved Double False Position method as called (Illinois method) has been termed; in section five results and discussion; finally in section six the conclusions..

2. Non-Linear Equation in Physical Example

Imagine Figure 1.

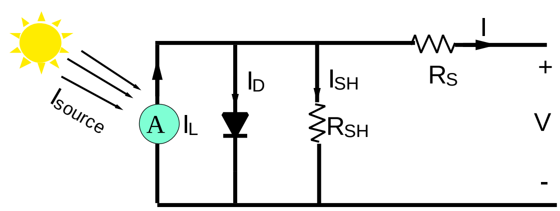

Fig. 1 – Single-diode model; electrical circuit.

Solving the values of V_{pv} in this circuit is achieved by (KCL) Kirchhoff's current law:

$$I = \mathrm{I_{ph}} - \mathrm{I_D} \tag{1}$$

$$\mathrm{I_D} = \mathrm{I_0} \times (e^{(-V_{pv}/mV_T)} - 1) \tag{2}$$

$$\mathrm{I} = \mathrm{I_{ph}} - \mathrm{I_0}\left(\mathrm{e}^{(-V_{pv}/mV_T)} - 1\right) \tag{3}$$

where:

$\mathrm{T}, \mathrm{I_0}, 1 < \mathrm{m} < 2, \mathrm{I_{ph}}, \mathrm{k}$and $\mathrm{V_T} = \mathrm{kT/q} = 26\ \mathrm{mV}$, q:, temperature (K), reverse saturation current, the recombination factor, the photocurrent (A), Boltzmann constant= 1.38×10^{-23}J/K, thermic voltage and the electron charge= 1.6×10^{-19} C respectively.

$$\mathrm{I_{ph}} = \mathrm{I_{source}} \tag{4}$$

$$\mathrm{I_D} = \mathrm{I_s} \times \left(\mathrm{e}^{(V_D/mV_T)} - 1\right) \tag{5}$$

By combine Eq. 4 in Eq. 5 yield

$$(\mathrm{I_{source}}) - 10^{-12}\left(e^{(-V/1.2\times0.026)} - 1\right) = \mathrm{V/R} \tag{6}$$

$$\mathrm{I_{pv}} = \mathrm{V_{pv}}/R;\ \mathrm{P_{pv}} = \mathrm{I_{pv}} \times \mathrm{V_{pv}} \tag{7}$$

where $\mathrm{I_s}$ reverse saturation current= 10^{-12}A. In parallel, $\mathrm{V} = \mathrm{V_D} = \mathrm{V_{pv}}$

$\mathrm{V_{pv}}$ has been determined numerically using Eq. 6 for the proposed method without any derivative of this equation.

3. Newton's Method

The following algorithm suggestion for solving Eq. 6 by using NRM

[1] Let the initial guess $\mathrm{x_0} = 1$.
[2] Define $\mathrm{x} = 0$
[3] while $\mathrm{i} \le \mathrm{x_0}$

[4] Compute $x_{n+1} = x_n - \frac{f(x_n)}{\acute{f}(x_n)}$ for $n = 0, 1, 2, \ldots$. The approximate solution (8)

[5] If $|x_i - x_{i-1}| < \varepsilon = 10^{-9}$ (tolerance); then determine x_{n+1} and stop. (9)

[6] Put $n = n + 1$; $i = i + 1$ and go to 2.

[7] Output.

4. Improved Double False Position Method [Illinois Algorithm] (IRFM)

Regula Falsi method is a root-finding algorithm, for solving nonlinear equations of the form $y = f(x_n) = 0$. It is old method for solving such equations but it is still in use. Several kinds of a false position technique is recognized, simple false position and double false position methods.

Double false position method (DFPM) is used to solve difficult examples that can be written algebraically in the form: calculate x so

$$f(x) = ax + b, \tag{10}$$

then

$$f(x_1) = b_1, f(x_2) = b_2 \tag{11}$$

Using a pair of initial test values x_0, x_1; the output results of this method is given by the recurrence relation

$$x = b_1 x_2 - b_2 x_1/(b_1 - b_2) \tag{12}$$

If the function is linear yield

$$f(x) = ax + c \tag{13}$$

DFOM gives the exact solution, but the nonlinear function f gives an approximation improve using iteration.

The Illinois method halves the y −value of the possessed end point in the next estimate calculation when the new y −value $(f(c_k))$ has the same sign as the previous one $(f(c_k - 1))$, meaning that the end point of the previous step will be possessed; as a result

$$c_k = \frac{1}{2} f(b_k) a_k - f(a_k) b_k / \frac{1}{2} f(b_k) - f(a_k) \text{ or } c_k = f(b_k) a_k - \frac{1}{2} f(a_k) b_k / f(b_k) - \frac{1}{2} f(a_k) \tag{14}$$

The tolerance $\varepsilon = 10^{-9}$; and $\sigma = |x_{n+1} - x_n| < \varepsilon$, $|f(x_n)| < \varepsilon$ to estimate the root of function.

5. Numerical Example and Remarks

In this section, we applied the present techniques has been defined by (8) and (14) in order to solving PV non-linear equation which show the theoretical results have been derived from (6). Table 1-6 and Figures 2-5 displayed the approximation V_{pv} with the initial test values x_0 is used for NRM and test values x_0, x_1 for the proposed method IRFM in the condition of load resistance $R = (1 - 5)$ ohm respectively. The value of the PV voltage V_{pv} has been determined using the same non-linear equation (6) for the two techniques. Moreover, the computational order of convergence (the tolerance of the two methods) ε is reported in these tables and figures. The effectiveness and accuracy of the NRM and IRFM have been tested by displaying the accuracy of the zeros of a nonlinear equation. The main goal of investigating the NRM and IRFM of a non-linear equation was to illustrate the accuracy of the approximate solution for V_{pv} values and the stability of the cxonvergence, the consistency of the results obtained and to calculate the efficiency of the new suggested technique. The new suggested technique need six iterations in order to reach to the convergence on contrast the other method NRM which need nine iterations for the same purpose. Thus, the IRFM can be considered a very good alternative method to the NRM.

Table 1 - Comparison of NRM and IRFM.

Iterations	V_{pv}-NRM	I_{pv}- NRM	P_{pv}-NRM	V_{pv}-IRFM	I_{pv}-IRFM	P_{pv}-IRFM	ε-NRM	ε- IRFM
1	1	1	1	0.942216008	0.942216008	0.887771005	0.077576865	0.019792873
2	0.971416861	0.971416861	0.943650719	0.927694471	0.927694471	0.860617031	0.048993727	0.005271336
3	0.946732606	0.946732606	0.896302627	0.922901876	0.922901876	0.851747873	0.024309472	0.000478742
4	0.929865706	0.929865706	0.864650231	0.922428674	0.922428674	0.850874659	0.007442571	5.5397E-06
5	0.923247893	0.923247893	0.852386673	0.922423135	0.922423135	0.850864441	0.000824759	9.515E-10
6	0.922434	0.922434	0.850884484	0.922423135	0.922423135	0.850864439	1.08655E-05	0
7	0.922423136	0.922423136	0.850864443				1.9025E-09	
8	0.922423135	0.922423135	0.850864439				1.11022E-16	
9	0.922423135	0.922423135	0.850864439				0	

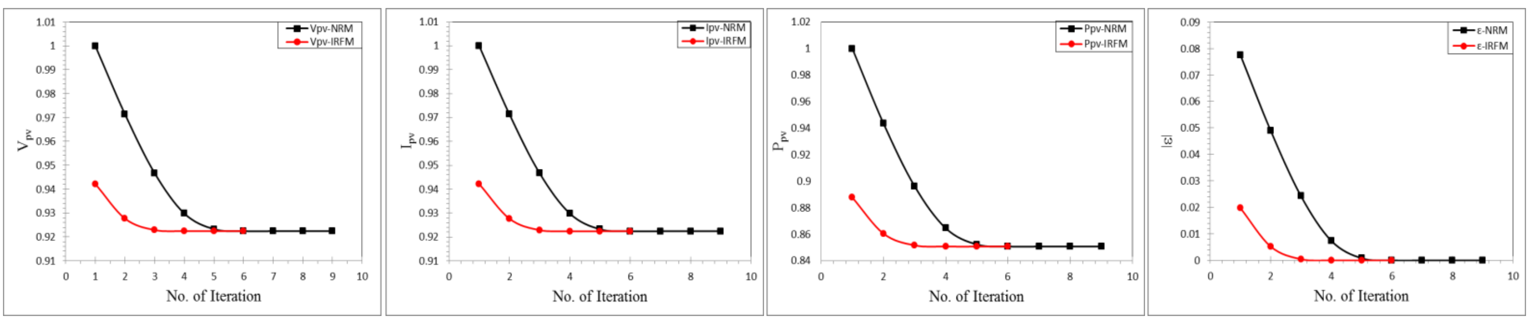

Fig. 2 – Numerical approach of Eq. 6 based on NRM and IRFM.

The examine function in Eq. 6 after 1st derivative using two methods NRM and RFM and the approximation V_{pv} for the examine function including the initial estimate value v_0 with the (tolerance ε) value are displayed in Table 2.

Table 2 - Comparison of NRM and IRFM.

Iterations	V_{pv}-NRM	I_{pv}- NRM	P_{pv}-NRM	V_{pv}-IRFM	I_{pv}-IRFM	P_{pv}-IRFM	ε-NRM	ε- IRFM
1	1	0.5	0.5	0.94057085	0.470285425	0.442336762	0.082964618	0.023535468
2	0.971030472	0.485515236	0.471450089	0.924204903	0.462102452	0.427077352	0.05399509	0.007169521
3	0.945421967	0.472710983	0.446911348	0.917881577	0.458940788	0.421253294	0.028386584	0.000846194
4	0.926834477	0.463417238	0.429511073	0.917051661	0.45852583	0.420491874	0.009799094	1.62783E-05
5	0.918438746	0.459219373	0.421764865	0.91703539	0.458517695	0.420476954	0.001403363	8.06498E-09
6	0.917066885	0.458533442	0.420505836	0.917035382	0.458517691	0.420476946	3.15024E-05	1.88738E-15
7	0.917035399	0.458517699	0.420476961	0.917035382	0.458517691	0.420476946	1.61176E-08	0
8	0.917035382	0.458517691	0.420476946				4.21885E-15	
9	0.917035382	0.458517691	0.420476946				0	

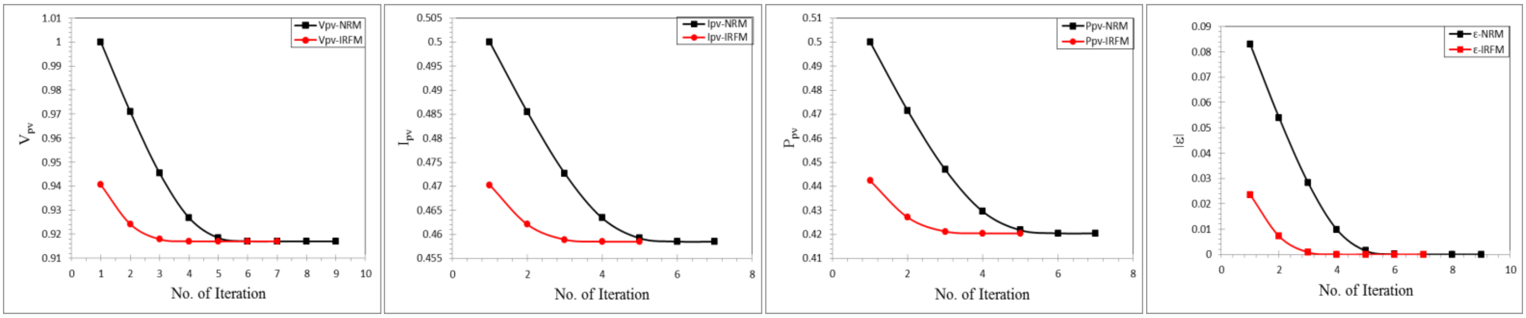

Fig. 3 - Numerical approach of Eq. 6 based on NRM and IRFM.

Table 3 - Comparison of NRM and IRFM.

Iterations	V_{pv}-NRM	I_{pv}- NRM	P_{pv}-NRM	V_{pv}-IRFM	I_{pv}-IRFM	P_{pv}-IRFM	ε-NRM	ε- IRFM
1	1	0.333333333	0.333333333	0.938877255	0.312959085	0.293830166	0.089596626	0.028473881
2	0.970643792	0.323547931	0.31404979	0.920408721	0.306802907	0.282384071	0.060240418	0.010005347
3	0.944084232	0.314694744	0.297098346	0.911969859	0.303989953	0.277229674	0.033680858	0.001566485
4	0.923594243	0.307864748	0.284342109	0.910455191	0.303485064	0.276309552	0.013190869	5.18173E-05
5	0.91287784	0.304292613	0.277781984	0.910403453	0.303467818	0.276278149	0.002474466	7.88982E-08
6	0.910501262	0.303500421	0.276337516	0.910403374	0.303467791	0.276278101	9.78883E-05	2.03726E-13
7	0.910403531	0.303467844	0.276278197	0.910403374	0.303467791	0.276278101	1.57417E-07	0
8	0.910403374	0.303467791	0.276278101				4.07563E-13	
9	0.910403374	0.303467791	0.276278101				0	

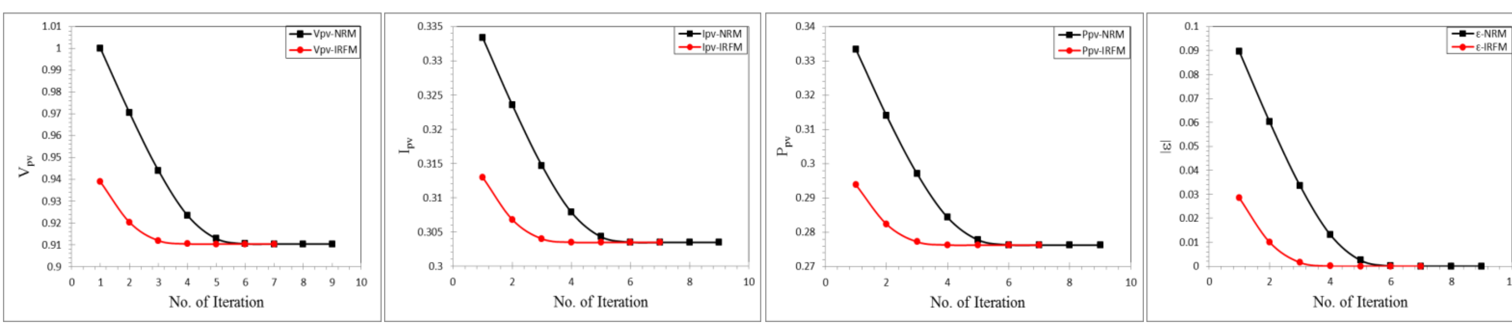

Fig. 4 - Numerical approach of Eq. 6 based on NRM and IRFM.

Table 4 - Comparison of NRM and IRFM.

Iterations	V_{pv}-NRM	I_{pv}- NRM	P_{pv}-NRM	V_{pv}-IRFM	I_{pv}-IRFM	P_{pv}-IRFM	ε-NRM	ε- IRFM
1	1	0.25	0.25	0.937133368	0.234283342	0.219554737	0.098259398	0.035392766
2	0.970256822	0.242564205	0.235349575	0.916262647	0.229065662	0.209884309	0.06851622	0.014522045
3	0.94271872	0.23567968	0.222179646	0.904846066	0.226211516	0.204686601	0.040978118	0.003105464
4	0.920123009	0.230030752	0.211656588	0.901927296	0.225481824	0.203368212	0.018382407	0.000186694
5	0.906346494	0.226586624	0.205365992	0.90174156	0.22543539	0.20328446	0.004605892	9.5847E-07
6	0.902077706	0.225519427	0.203436047	0.901740602	0.225435151	0.203284028	0.000337104	3.03469E-11
7	0.901742503	0.225435626	0.203284885	0.901740602	0.22543515	0.203284028	1.90088E-06	0
8	0.901740602	0.225435151	0.203284028				6.06911E-11	
9	0.901740602	0.22543515	0.203284028				0	

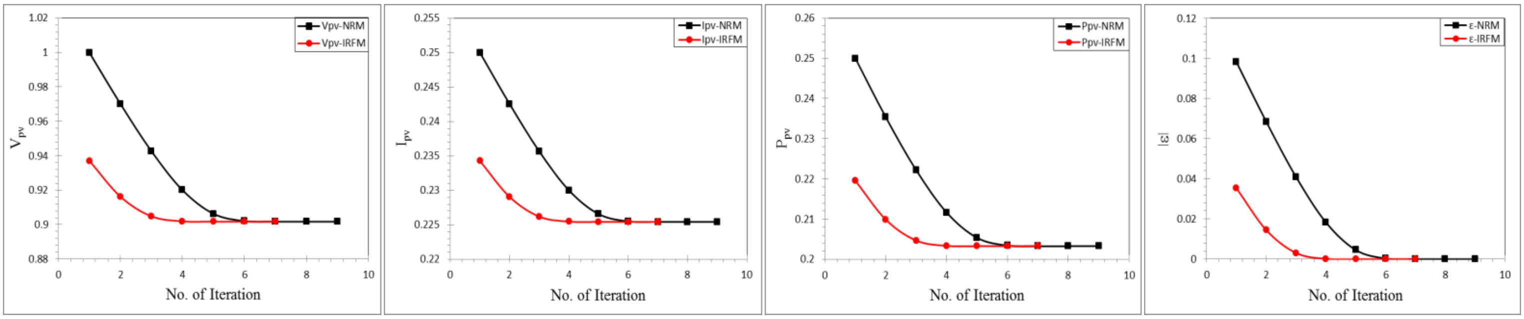

Fig. 5 - Numerical approach of Eq. 6 based on NRM and IRFM.

Table 5 - Comparison of NRM and IRFM.

Iterations	V_{pv}-NRM	I_{pv}- NRM	P_{pv}-NRM	V_{pv}-IRFM	I_{pv}-IRFM	P_{pv}-IRFM	ε-NRM	ε- IRFM
1	1	0.2	0.2	0.935337263	0.187067453	0.174971159	0.110907285	0.046244548
2	0.96986956	0.193973912	0.188129393	0.911715654	0.182343131	0.166245087	0.080776845	0.022622939
3	0.941324731	0.188264946	0.17721845	0.896015489	0.179203098	0.160568751	0.052232016	0.006922775
4	0.916395843	0.183279169	0.167956268	0.889931165	0.177986233	0.158395496	0.027303128	0.000838451
5	0.898535645	0.179707129	0.161473261	0.889109827	0.177821965	0.158103257	0.00944293	1.71125E-05
6	0.890477009	0.178095402	0.158589861	0.889092724	0.177818545	0.158097174	0.001384294	9.60373E-09
7	0.889125763	0.177825153	0.158108925	0.889092715	0.177818543	0.158097171	3.30483E-05	3.10862E-15
8	0.889092734	0.177818547	0.158097178	0.889092715	0.177818543	0.158097171	1.91907E-08	0
9	0.889092715	0.177818543	0.158097171				6.43929E-15	
10	0.889092715	0.177818543	0.158097171				0	

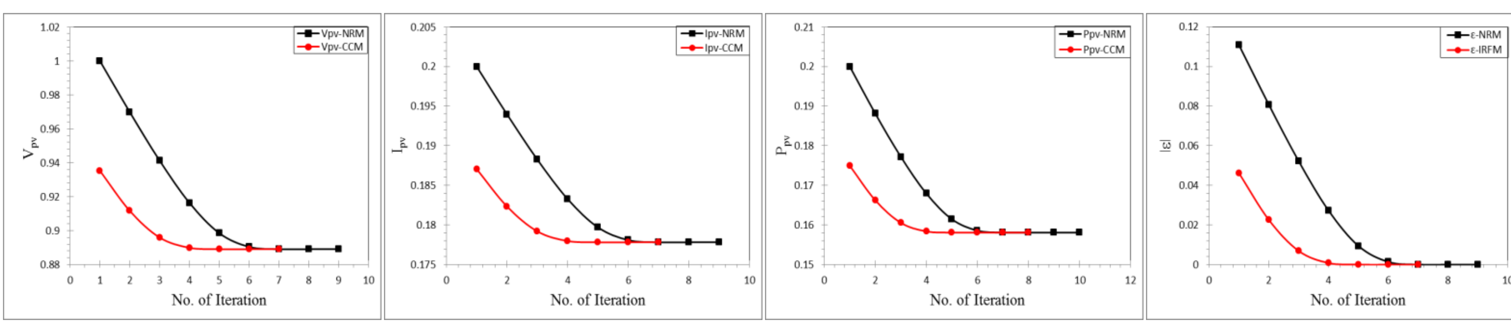

Fig. 6 - Numerical approach of Eq. 6 based on NRM and IRFM.

6. Conclusion

Modified double false position method is applied to numerical solution for solving real zeroes of nonlinear equation based on non-linear equation Eq. 6 in ambient temperature. Comparison of the results acquired by the proposed method with existing method (NRM) reveal that the presented method are very effective, accurate, convenient and easy to use. We employed Illinois algorithm and Newton's techniques in order to solve a non-linear equation of a PV cell.

References

[1] M. RASHEED, and M. A. Sarhan, "Solve and Implement the main Equations of Photovoltaic Cell Parameters Using Visual Studio Program", Insight-Mathematics, vol. 1 (1) (2019), pp. 17-25.

[2] M. Rasheed, and M. A. Sarhan, "Characteristics of Solar Cell Outdoor Measurements Using Fuzzy Logic Method", Insight-Mathematics, vol. 1 (1) (2019), pp. 1-8.

[3] M. RASHEED, and M. A. Sarhan, "Measuring the Solar Cell Parameters Using Fuzzy Set Technique", Insight-Electronic, vol. 1 (1) (2019), pp. 1-9.

[4] M. RASHEED, "Linear Programming for Solving Solar Cell Parameters", Insight-Electronic, vol. 1 (1) (2019), pp. 10-16.

[5] M. RASHEED, "Investigation of Solar Cell Factors using Fuzzy Set Technique", Insight-Electronic, vol. 1 (1) (2019), pp. 17-23.
[6] M. RASHEED, and S. SHIHAB, "Analytical Modeling of Solar Cells", Insight Electronics, vol. 1 (2) (2019), pp. 1-9.
[7] S. SHIHAB, and M. RASHEED, "Modeling and Simulation of Solar Cell Mathematical Model Parameters Determination Based on Different Methods", Insight Mathematics, vol. 1 (1) (2019), pp. 1-16.
[8] M. RASHEED, and S. SHIHAB, "Parameters Estimation for Mathematical Model of Solar Cell", Electronics Science Technology and Application, vol. 6, (1) (2019), pp. 20-28.
[9] M. Rasheed, and S. Shihab, "Numerical Techniques for Solving Parameters of Solar Cell", Applied Physics, vol. 3 (1) (2020), pp. 16-27.
[10] M. RASHEED, and S. SHIHAB, "Modifications to Accelerate the Iterative Algorithm for the Single Diode Model of PV Model", Iraqi Journal of Physics (IJP), vol. 18 (47) (2020), pp. 33-43.
[11] M. S. Rasheed and S. Shihab, "Modelling and Parameter Extraction of PV Cell Using Single-Diode Model". Advanced Energy Conversion Materials, 1 (2) (2020), pp. 96-104. Available from: http://ojs.wiserpub.com/index.php/AECM/article/view/550.
[12] M. S. Rasheed, and S. Shihab, "Analysis of Mathematical Modeling of PV Cell with Numerical Algorithm". Advanced Energy Conversion Materials, vol. 1 (2) (2020), pp. 70-79. Available from: http://ojs.wiserpub.com/index.php/AECM/article/view/328.
[13] M. A. Sarhan, "Effect of Silicon Solar Cell Physical Factors on Maximum Conversion Efficiency Theoretically and Experimentally", Insight-Electronic, vol. 1 (1) (2019), pp. 24-30.
[14] Jalal, Rasha, Suha Shihab, Mohammed Abed Alhadi, and Mohammed Rasheed. "Spectral Numerical Algorithm for Solving Optimal Control Using Boubaker-Turki Operational Matrices", In Journal of Physics: Conference Series, vol. 1660, no. 1, p. 012090. IOP Publishing, (2020).
[15] M. M. Abbas and M. Rasheed, "Solid State Reaction Synthesis and Characterization of Cu doped TiO2 Nanomaterials", In Journal of Physics: Conference Series, IOP Publishing, (2021), in press.
[16] M. RASHEED, S. SHIHAB, O. W. Sabah, "An investigation of the Structural, Electrical and Optical Properties of Graphene-Oxide Thin Films Using Different Solvents", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[17] M. Rasheed, O. Y. Mohammed, S. Shihab, Aqeel Al-Adili, "A comparative Analysis of PV Cell Mathematical Model", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[18] M. Rasheed, O. Y. Mohammed, S. Shihab, Aqeel Al-Adili, "Explicit Numerical Model of Solar Cells to Determine Current and Voltage", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[19] M. Rasheed, O. Y. Mohammed, S. Shihab, Aqeel Al-Adili, "Parameters Estimation of Photovoltaic Model Using Nonlinear Algorithms", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[20] M. Enneffatia, M. Rasheed, B. Louatia, K. Guidaraa, S. Shihab, R. Barillé, "Investigation of structural, morphology, optical properties and electrical transport conduction of Li0.25Na0.75CdVO4 compound", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[21] 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", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[22] A. A. Abdulrahman , M. RASHEED and S. SHIHAB, "The Analytic of Image Processing Smoothing Spaces Using Wavelet", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[23] M. A. Sarhan, S. Shihab, B E Kashem and M. Rasheed, "New Exact Operational Shifted Pell Matrices and Their Application in Astrophysics", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[24] M. Rasheed, S. Shihab, O. Alabdali and H. H. Hussein, "Parameters Extraction of a Single-Diode Model of Photovoltaic Cell Using False Position Iterative Method", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[25] M. Rasheed, O. Alabdali and S. Shihab, "A New Technique for Solar Cell Parameters Estimation of The Single-Diode Model", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[26] M. Rasheed, and R. Barillé, "Room temperature deposition of ZnO and Al: ZnO ultrathin films on glass and PET substrates by DC sputtering technique", Optical and Quantum Electronics, vol. 49 (5) (2017), pp. 1-14.
[27] M. Rasheed, Régis Barillé, Optical constants of DC sputtering derived ITO, TiO2 and TiO2: Nb thin films characterized by spectrophotometry and spectroscopic ellipsometry for optoelectronic devices, Journal of Non-Crystalline Solids, vol. 476 (2017), pp. 1-14.
[28] M. Rasheed, R. Barillé, Comparison the optical properties for Bi2O3 and NiO ultrathin films deposited on different substrates by DC sputtering technique for transparent electronics, Journal of Alloys and Compounds, vol. 728 (2017), pp. 1186-1198.
[29] T. Saidani, M. Zaabat, M. S. Aida, R. Barille, M. Rasheed, Y. Almohamed, Influence of precursor source on sol–gel deposited ZnO thin films properties, Journal of Materials Science: Materials in Electronics, vol. 28 (13) (2017), pp. 9252-9257.
[30] K. Guergouria A. Boumezoued, R. Barille, D. Rechemc, M. Rasheed M. Zaabata, ZnO nanopowders doped with bismuth oxide, from synthesis to electrical application, Journal of Alloys and Compounds, vol. 791 (2019), pp. 550-558.
[31] D. Bouras, A. Mecif, R. Barillé, A. Harabi, M. Rasheed, A. Mahdjoub, M. Zaabat, Cu: ZnO deposited on porous ceramic substrates by a simple thermal method for photocatalytic application, Ceramics International, vol. 44 (17) (2018), pp. 21546-21555.
[32] W. Saidi, N. Hfaidh, M. Rasheed, M. Girtan, A. Megriche, M. EL Maaoui, Effect of B2O3 addition on optical and structural properties of TiO2 as a new blocking layer for multiple dye sensitive solar cell application (DSSC), RSC Advances, vol. 6 (73) (2016), pp. 68819-68826.
[33] A. AUKŠTUOLIS, M. Girtan, G. A. Mousdis, R. Mallet, M. Socol, M. Rasheed, A. Stanculescu, Measurement of charge carrier mobility in perovskite nanowire films by photo-CELIV method, Proceedings of the Romanian Academy Series a-Mathematics Physics Technical Sciences Information Science, vol. 18 (1) (2017), pp. 34-41.
[34] O. A. Sultan, K. I. Hassoon, M. S. Rasheed, Deterioration of Silicon Solar Cell Parameter with Ambient Temperature, Al-Mustansiriyah Journal of Science, vol. 14 (1) (2003), pp. 25-31.
[35] F. Dkhilalli, S. Megdiche, K. Guidara, M. Rasheed, R. Barillé, M. Megdiche, AC conductivity evolution in bulk and grain boundary response of sodium tungstate Na2WO4, Ionics, vol. 24 (1) (2018), pp. 169-180.
[36] F. Dkhilalli, S. M. Borchani, M. Rasheed, R. Barille, K. Guidara, M. Megdiche, Structural, dielectric, and optical properties of the zinc tungstate ZnWO4 compound, Journal of Materials Science: Materials in Electronics, vol. 29 (8) (2018), pp. 6297-6307.
[37] F. Dkhilalli, S. M. Borchani, M. Rasheed, R. Barille, S. Shihab, K. Guidara, M. Megdiche, Characterizations and morphology of sodium tungstate particles, Royal Society open science, vol. 5 (8) (2018), pp. 1-12.
[38] M. Enneffati, B. Louati, K. Guidara, M. Rasheed, R. Barillé, Crystal structure characterization and AC electrical conduction behavior of sodium cadmium orthophosphate, Journal of Materials Science: Materials in Electronics, vol. 29 (1) (2018), pp. 171-179.
[39] E. Kadri, M. Krichen, R. Mohammed, A. Zouari, 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 (12) (2016), pp. 1-15.
[40] E. Kadri, O. Messaoudi, M. Krichen, K. Dhahri, M. Rasheed, E. Dhahri, A. Zouari, K. Khirouni, R. Barillé, Optical and electrical properties of SiGe/Si solar cell heterostructures: Ellipsometric study, Journal of Alloys and Compounds, vol. 721 (2017), pp. 779-783.
[41] E. Kadri, K. Dhahri, A. Zaafouri, M. Krichen, M. Rasheed, K. Khirouni, R. Barillé, Ac conductivity and dielectric behavior of a−Si:H/c−Si1−yGey/p−Si thin films synthesized by molecular beam epitaxial method, Journal of Alloys and Compounds, vol. 705 (2017), pp. 708-713.
[42] N. B. Azaza, S. Elleuch, M. Rasheed, D. Gindre, S. Abid, R. Barille, Y. Abid, H. Ammar, 3-(p-nitrophenyl) Coumarin derivatives: Synthesis, linear and nonlinear optical properties, Optical Materials, vol. 96, (2019), pp. 109328.

[43] M. Enneffati, M. Rasheed, B. Louati, K. Guidara, R. Barillé, Morphology, UV–visible and ellipsometric studies of sodium lithium orthovanadate, Optical and Quantum Electronics, vol. 51 (9) (2019), vol. 299.
[44] M. M. Abbas and M. RASHEED, Investigation of structural, Mechanical, Thermal and Optical Properties of Cu Doped TiO2, Iraqi Journal of Physics (IJP), (2020), in press.
[45] M. S. Rasheed, "Approximate Solutions of Barker Equation in Parabolic Orbits", Engineering & Technology Journal, vol. 28 (3) (2010), pp. 492-499.
[46] M. S. Rasheed, "An Improved Algorithm For The Solution of Kepler‘s Equation For An Elliptical Orbit", Engineering & Technology Journal, vol. 28 (7) (2010), pp. 1316-1320.
[47] M. S. Rasheed, "Acceleration of Predictor Corrector Halley Method in Astrophysics Application", International Journal of Emerging Technologies in Computational and Applied Sciences, vol. 1 (2) (2012), pp. 91-94.
[48] M. S. Rasheed, "Fast Procedure for Solving Two-Body Problem in Celestial Mechanic", International Journal of Engineering, Business and Enterprise Applications, vol. 1 (2) (2012), pp. 60-63.
[49] M. S. Rasheed, "Solve the Position to Time Equation for an Object Travelling on a Parabolic Orbit in Celestial Mechanics", DIYALA JOURNAL FOR PURE SCIENCES, vol. 9 (4) (2013), pp. 31-38.
[50] M. S. Rasheed, "Comparison of Starting Values for Implicit Iterative Solutions to Hyperbolic Orbits Equation", International Journal of Software and Web Sciences (IJSWS), vol. 1 (2) (2013), pp. 65-71.
[51] M. S. Rasheed, "On Solving Hyperbolic Trajectory Using New Predictor-Corrector Quadrature Algorithms", Baghdad Science Journal, vol. 11 (1) (2014), pp. 186-192.
[52] M. S. Rasheed, "Modification of Three Order Methods for Solving Satellite Orbital Equation in Elliptical Motion", Journal of university of Anbar for Pure science, vol. 14 (1) (2020), pp. 33-37.
[53] M. RASHEED, S. SHIHAB and T. RASHID, "Parameters Determination of PV Cell Using Computation Methods", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 1-9.
[54] R. J. Mitlif, M. RASHEED, S. SHIHAB and T. RASHID, "Linear Programming Method Application in a Solar Cell", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 10-21.
[55] M. N. Mohammedali, M. RASHEED, S. SHIHAB and T. RASHID, "Optimal Parameters Estimation of Silicon Solar Cell Using Fuzzy Logic: Analytical Method", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 22-33.
[56] M. RASHEED, Osama Alabdali, S. SHIHAB and T. RASHID, "Evaluation and Determination of the Parameters of a Photovoltaic Cell by an Iterative Method", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 34-42.
[57] M. RASHEED, S. SHIHAB, T. RASHID and T. D. Ounis, "Determination of PV Model Parameters Using Bisection and Secant Methods", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13, (1), (2021), 43-54.
[58] R. I. Sabri, M. RASHEED, O. Alabdali, S. SHIHAB and T. RASHID, "On Some Properties in Fuzzy Metric Space", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 55-61.
[59] M. N. Mohammedali, M. RASHEED, S. SHIHAB and T. RASHID, "Fuzzy Set Technique Application: The Solar Cell", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 62-69.
[60] S. H. Aziz, S. SHIHAB, M. RASHEED, "On Some Properties of Pell Polynomials", Al-Qadisiyah Journal of Pure Science, vol. 26, (1), (2020), pp. 39-54.
[61] M. A. Sarhan, S. SHIHAB, M. RASHEED, "Some Results on a Two Variables Pell Polynomials", Al-Qadisiyah Journal of Pure Science, vol. 26, (1), (2020), pp. 55-70.
[62] M. RASHEED, S. SHIHAB, T. RASHID, "Two Step and Newton- Raphson Algorithms in the Extraction for the Parameters of Solar Cell", Al-Qadisiyah Journal of Pure Science, vol. 26 (1), (2021), pp.143-154.
[63] M. A. Sarhan, S. SHIHAB, M. RASHEED, "A novel Spectral Modified Pell Algorithm for Solving Singular Differential Equations", Al-Mustansiriyah Journal of Science, vol. 32, (1), (2021), In press.
[64] M. RASHEED, S. SHIHAB and T. RASHID, "Determining the Voltage and Power of a Single Diode PV Cell in Matlab by Iteration", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 70-78.
[65] M. RASHEED, S. SHIHAB and T. RASHID, "Some Step Iterative Method for Finding Roots of a Nonlinear Equation", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 95-102.
[66] M. RASHEED, S. SHIHAB and T. RASHID, "Two Numerical Algorithms for Solving Nonlinear Equation of Solar Cell", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 87-94.