iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.51505

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Simulation of a Battery Charging and Discharging Using Matlab

Shandeep Vignesh H S[1], Arun Prasad P M[2] , Santhosh Raju R[3], Mr. R Vishnurameshkumar[4]
[1, 2, 3] Student, [4]Assistant Professor, Department of Automobile Engineering, Dr Mahalingam College of Engineering and Technology

Abstract: The modelling and simulation of the batteries are the subjects of this study. It requires using MATLAB to understand the mathematical link between the battery input, output, and simulator parameters. Currently, we observe an increase in interest in the power system from entities like electric utilities, energy service providers, auto manufacturers, etc. This paper demonstrates how to simulate charging or discharging using Simulink and MATLAB. Since its development over the past century, electricity has become the most adaptable and common type of energy used worldwide. With the help of batteries, we may store electrical energy in the form of chemical energy, which can later be used to produce electricity once more.
Keywords: Battery, State of charge (SOC), simulation, and open circuit voltage (OCV).

I. INTRODUCTION

This project uses MATLAB/Simulink to create a very simple model to determine how batteries charge and discharge. to browse between requirements, designs, generated code, and tests. To create links with drag and drop. To annotate diagrams with requirements context. Changes are beneficial as well.

It determines the implementation and verification status when related requirements, designs, or tests take place in accordance with the specifications.

In the battery system model and simulate algorithm is using Simulink and Stateflow including:

1) Tracking voltage and current
2) State of Charge (SOC) estimation
3) Supervisory reasoning
4) Power input and output restrictions for overcharge and discharge defence, etc.The accompanying areas show the proposed battery model's battery parameterized technique and strategy, which are the outcomes of exhaustive battery portrayal tests.

II. PRINCIPLE AND STRUCTURE OF BATTERY CHARGING / DISCHARGING CHARACTERISTICS

The first step in creating and parameterizing an analogous circuit that depicts battery behaviour is to create an accurate battery model. utilising Data from measured lithium-ion, nickel-metal hydride, or lead-acid batteries, along with MATLAB and an estimating technique. as a result of the high specific energy densities of lithium-ion batteries, high energy densities, and long cycling lives, we use them in this project. Current pulses for charging and discharging are utilised to parameterize. MATLAB may be used to create mathematical models for predicting and optimising the behaviour of complex systems. Following steps are considered for the model development are:

1) Create models utilising approaches for data fitting and first-principles modelling.
2) Determine the variables that improve system performance.
3) Create specialised post-processing procedures when simulating models
4) Create reports that detail model development and simulation findings.

III. STATE OF CHARGE (SOC)

State of charge refers to a battery's level of charge in relation to its capacity. SOC, which stands for state of charge, is a crucial metric for the control strategy. The charging and draining of the battery are shown by the SOC characteristics, depending on the level or range. When the voltage is high, the battery is fully charged, and when it drops to its lowest level, the battery is discharged. The two most popular and straightforward ways for determining a battery's SOC are (a) the OCV approach and (b) the coulomb counting method. SOC Calculation for the battery model:

$SOC(t) = Qt / Qn$

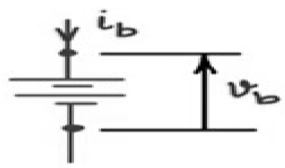
SOC is the most important battery parameters and A battery's SOC is calculated as the difference between its current capacity (Qt) and nominal capacity (Qn). The manufacturer provides the nominal capacity (Qn), which represents maximum value of charge that can be stored in the battery. Capacity was considered as a function of current and to determine the effect of capacity on the current of the battery cell. Then the calculation of SOC is

$$SOC = SOC\Big|_o - \frac{1}{C_n}\int_0^t I(t)\,dt$$

Where, C_n is the starting SOC is 0 and capacity I is the current SOC.

IV. BATTERY CAPACITY

The energy stored in a battery is called a battery capacity. It is measured in amp hours, watt hours, or kilowatts hours (AH, WH, KWH). One of the battery parameters is BATTERY CAPACITY. AN EXAMPLE WILL HELP US TO EXPLAIN:
Let us have a voltage vb, and flowing current is ib. then the energy is
$\int v_B . I_B . DT$ = Energy capacity in Wh or
$\int I_B . DT$ = Charge capacity in Ah



• If ib is positive, it is charging the battery by flowing into a positive terminal. The computed energy will then be used for charging.

$$SOC = SOC\Big|_o - \frac{1}{C_n}\int_0^t I(t)\,dt$$

• If current ib is flowing out of the terminal and is going in the opposite direction, this means there has been an energy discharge.
The quantity of energy a battery can store or discharge to a load is hence known as its capacity. The battery's actual capacity can be determined by its Wh capacity or energy capacity. If vb is constant, then Wh can be calculated using charge capacity (C) or ah. Therefore, the Charge Capacity (C) or Ah battery is most frequently used for business purposes. By discharging a fully charged battery through an applied load at a constant current rate, the capacity of a battery is determined.

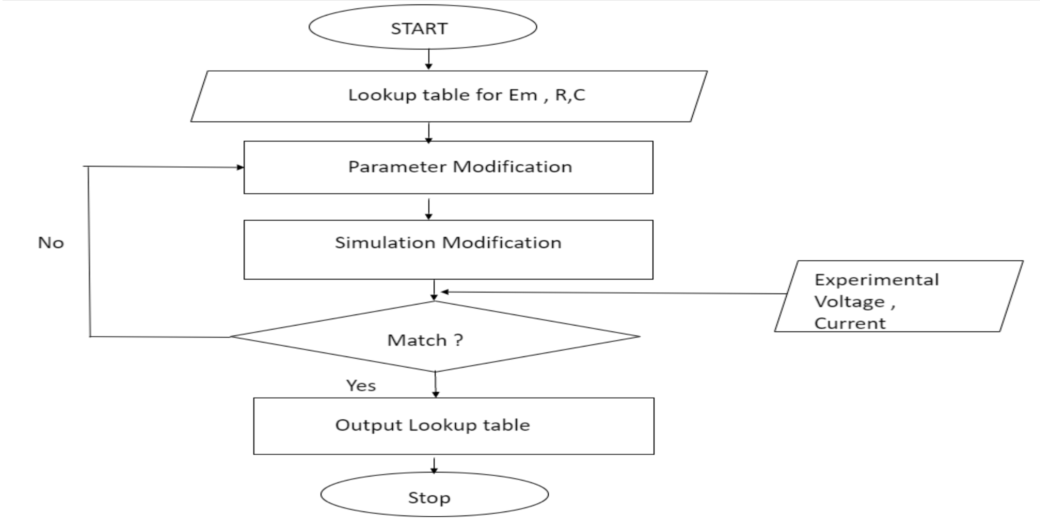
V. MODELLING AND SIMULATION OF BATTERY

Understanding The input and output characteristics of the battery and the simulator must be modelled mathematically in order to simulate the battery. An under-control voltage source based on the actual state of charge (SOC) is used in this instance. Modelling and simulation are essential for determining capacity and choosing the best components for an electrical system. They are also crucial for designing batteries and approximating battery performance. The idea of collecting parameters from manufacturer discharge characteristics is included in the description of battery modelling. This quality provides a quick, accurate, and practical solution that is good for batteries. Echarge=f1(it, i*, Exp, Batt Type) and Edischarge=f2(it, i*, Exp, Batt Type) are the general models for charge and discharge.
Whereas its functions are e-charge and e-discharge (Extracted)
To design a battery management system (BMS), you must first create a high-fidelity battery model. To enable a BMS to estimate critical battery properties, such as the battery state of charge and state of health, a trustworthy estimation approach must be utilised in conjunction with an accurate battery model. In other words, a battery model is a set of mathematical equations that describe what actually occurs inside a battery.
In layman's terms, as indicated in the image, the battery and battery model should provide the same voltage profile and the error between the two signals should be near to zero if the same current profile is applied to both. The model is able to forecast the behaviour of the battery in a way that if we applied an estimator, we can predict critical parameters such as the battery SOH and remaining useful life.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

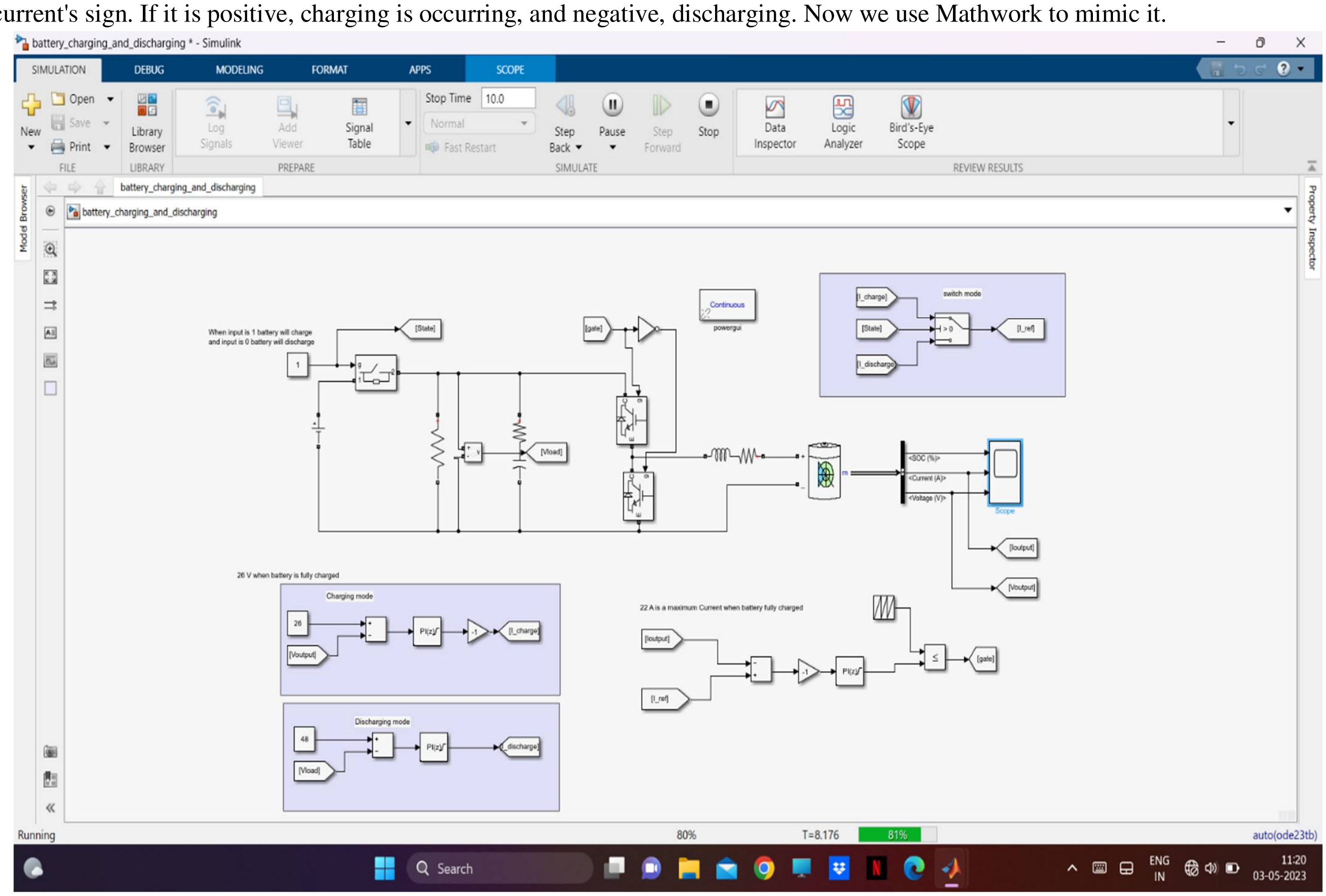
VI. SIMULATION OF BATTERY MODEL

In MATLAB/Simulink, a battery simulation model is built that includes a cell parameters module for a lookup during charging and discharging operations.

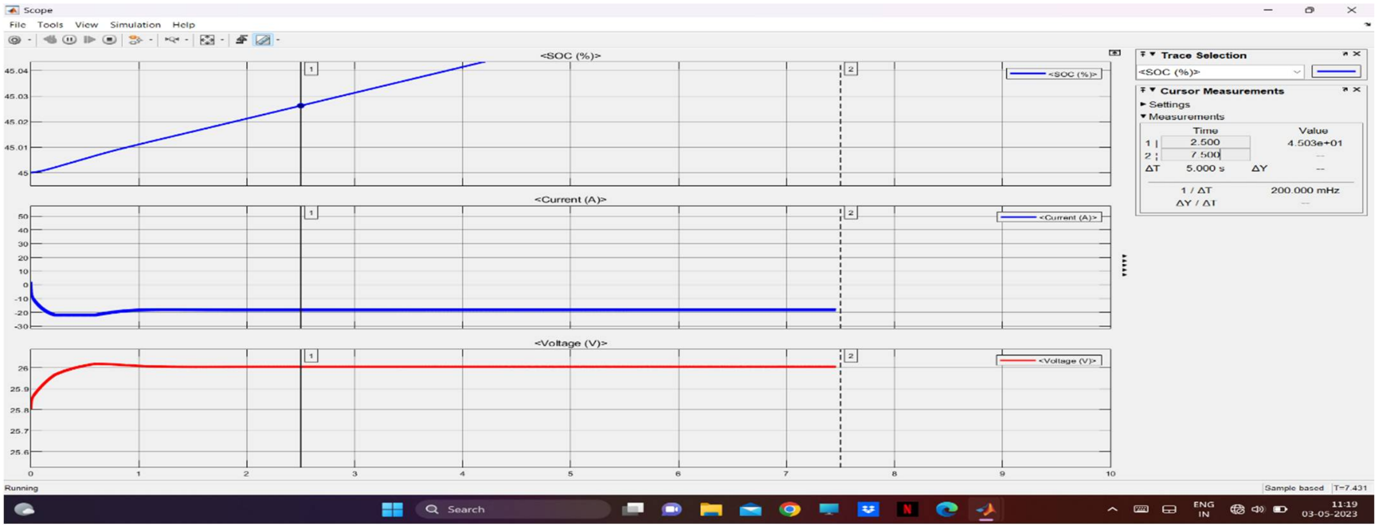


VII. IDENTIFICATION OF THE DYNAMIC PARAMETERS

We must assess the battery's remaining charge in this project so that we can accurately describe it. On the other hand, we can assert that we must be aware of the battery's behaviour when it is fully charged, halfway charged (i.e., 50% state of charge), or fully discharged. Create a model now to track and attempt to comprehend battery behaviour. In the fundamentals, we are aware of the current's sign. If it is positive, charging is occurring, and negative, discharging. Now we use Mathwork to mimic it.



VIII. RESULT



IX. FUTURE SCOPE

Studies show that people are constantly looking for methods to improve with new ideas and take on new challenges.

Future challenges include a pacemaker battery charging model using MATLAB/Simulink and wireless power transmission. Additionally, Japan is still researching sodium-ion batteries while also studying a new kind of battery that will be available soon.

X. CONCLUSION

This research utilises MATLAB-Simulink to demonstrate the parameterization of the battery's charging and discharging behaviour. The inquiry of the dynamic characteristics of lithium-ion batteries was aided by this report. The lithium-ion battery cell's capacity, open-circuit voltage (OCV), and internal resistance were studied at a range of load currents and states of charge (SOCs). The model covers all the parameters and can be improved and used in future study in accordance with the various loads or requirements.

REFERENCES

[1] L. W. Yao and J. A. Aziz, "Modeling of Lithium Ion battery with nonlinear transfer resistance," 2011 IEEE Applied Power Electronics Colloquium, IAPEC 2011, pp. 104– 109, 2011, doi: 10.1109/IAPEC.2011.5779865.

[2] W. Y. Chang, "Estimation of the state of charge for a LFP battery using a hybrid method that combines a RBF neural network, an OLS algorithm and AGA," International Journal of Electrical Power and Energy Systems, vol. 53, no. 1, pp. 603– 611, 2013, doi: 10.1016/j.ijepes.2013.05.038.

[3] Thai Innovation and Technology Association and Institute of Electrical and Electronics Engineers, The 2016 Management and Innovation Technology International Conference (MITiCON2016) : October 12-14, 2016, the TIDE Resort, Bang-Saen, Chonburi, Thailand.

[4] Z. Cai, G. Liu, and J. Luo, "Research state of charge estimation tactics of nickelhydrogen battery," Proceedings - 2010 International Symposium on Intelligence 10 E3S Web of Conferences 353, 03001 (2022) https://doi.org/10.1051/e3sconf/202235303001 EVF'2021 Information Processing and Trusted Computing, IPTC 2010, pp. 184–187, 2010, doi: 10.1109/IPTC.2010.91.

[5] Simscape 2018 Model and simulate multidomain physical systems, Accessed March 1, 2018, https://www.mathworks.com/products/simscape.html. Google Scholar.

[6] M. A. Roscher, J. Assfalg, and O. S. Bohlen, "Detection of utilizable capacity deterioration in battery systems," IEEE Transactions on Vehicular Technology 60(1), 98–103 (2011). https://doi.org/10.1109/tvt.2010.2090370, Google ScholarCrossref .

[7] Adrien Genić, Stevan Grabić, Evgenije Adžić, Milan Adžić, Nikola Ĉelanović "HIL400/800 HARDWARE AND ACCESSORIES" 16th International Symposium on Power Electronics - 2011 NOVI SAD, Republic of Serbia, October 26th - 28th, 2011 pp1-5.

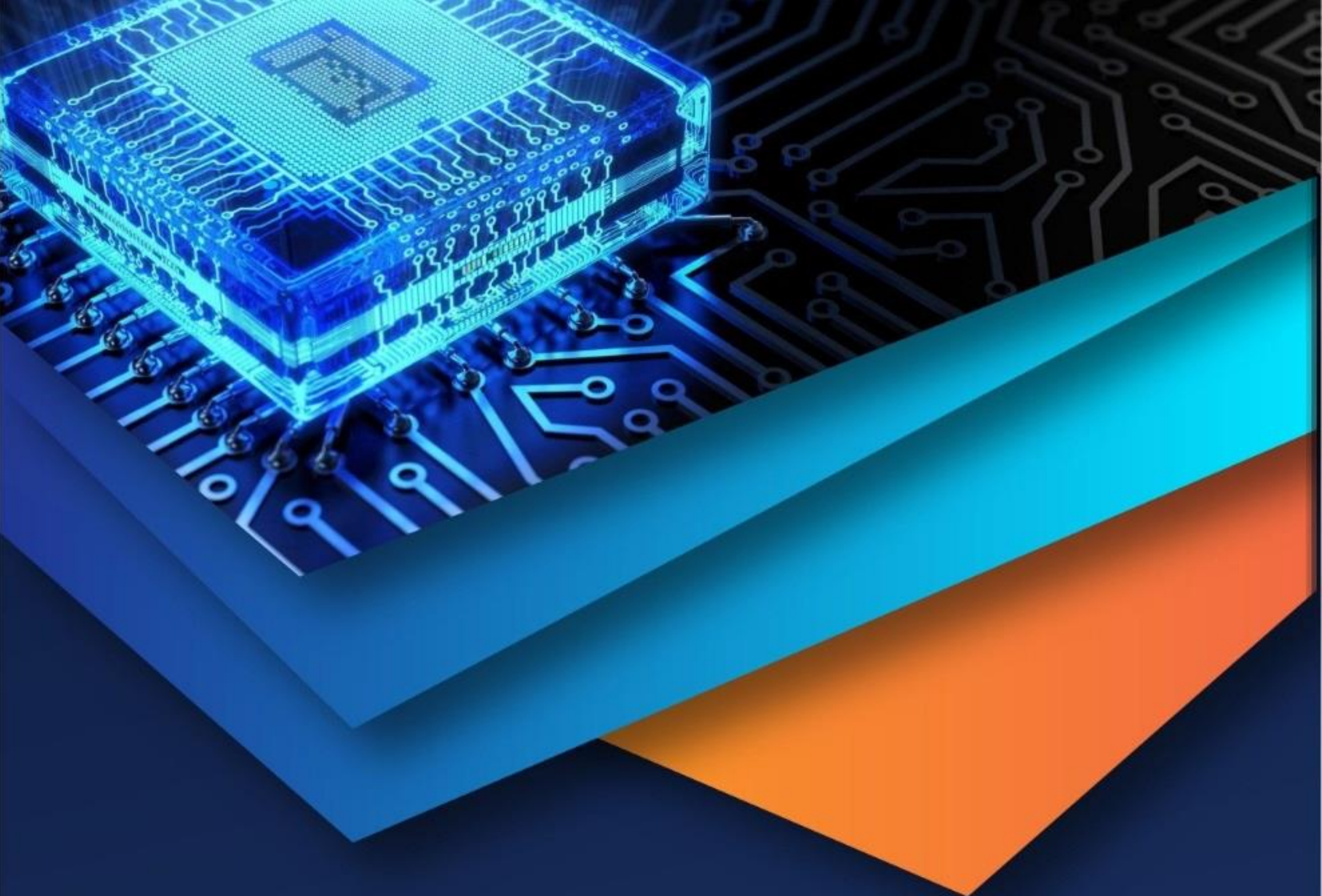
[8] Jackey, R., "A Simple, Effective Lead-Acid Battery Modeling Process for Electrical System Component Selection," SAE Technical Paper 2007-01-0778, 2007

[9] Renewable sources of energy text book by B.H Khan.

[10] Research Gate State-of-the art off battery state-of-charge determination article in Measurement Science and Technology 16(4) December 2005.

[11] Electric machinery test book by J.B Gupta.

[12] M. Chen and G. Rincón-Mora. Accurate Electrical Battery Model Capable of Predicting Runtime and I-V Performance. IEEE Trans. On Energy Conversion.21(2):504-511, 2006.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)