

# **Shri Shivaji College of Arts, Commerce and Science, Akola**

## **FINAL PROGRESS REPORT OF UGC SPONSORED MINOR RESEARCH PROJECT**

**Entitled**

**“ DC Voltage Generation From Live Plants/Trees And  
Its Utilization In General Circuits ”**

**Duration of Project :- April 2013 to April 2015**

**UGC File No. :- 47-025/12(PRO), 25/02/2013**

**Date of Implementation :- 22<sup>nd</sup> April, 2013**

**Principal Investigator :- Gajanan Shankarrao Wajire  
( Asst. Prof. in Electronics )**

**Shri Shivaji College of Arts, Commerce and Science,  
Akola (M.S.) - 444003.**

Received  
of

UNIVERSITY GRANTS COMMISSION  
WESTERN REGIONAL OFFICE  
GANESHKHIND, PUNE - 411007

Phones: (020) 25696897,  
25691477, 25691178,  
Fax: (020) 25691477  
Web site: www.ugc.ac.in

File No: 47-025/12(WRO)

The Accounts Officer  
University Grants Commission  
Ganeshkhind, Pune-411007.

*Prof Wajire*  
*du needed*

25 FEB 2013

**Subject: Financial assistance to college teachers for undertaking Minor Research Projects -  
Release of first installment during XII<sup>th</sup> Plan.**

Sir/Madam,

The UGC on the recommendations of the Expert Committee has approved the Minor Research Project entitled "DC Voltage generation from live plants/trees and its Utilization in general circuits" in the subject- Electronics to be undertaken by Mr. Wajire G. S., SHRI SHIVAJI COLLEGE, AKOT ROAD, , AKOLA-444 003. The financial assistance of the UGC would be limited to Rs. 105000/-(Rupees Only) for a period of two years. An amount of Rs. 85000/- (Rupees Only) is presently being sanctioned as the first installment.

| Non-Recurring Grant for Two years | Amount (Rs) | Recurring grant       | 1 <sup>st</sup> Year Amount | 2 <sup>nd</sup> Year Amount | Head of a/c   |
|-----------------------------------|-------------|-----------------------|-----------------------------|-----------------------------|---|
| Books & Journals                  | 15000       | Contingency           | 5000                        | 5000                        | 4(iv)b<br>(For General)<br>1.B(i)h(i)b<br>(For SC)<br>1.B(i)h(i)b<br>(For ST) |
| Equipment                         | 50000       | Special Need          | 0                           | 0                           |   |
|                                   |             | Travel/Field work     | 7500                        | 7500                        |   |
|                                   |             | Chemicals & Glassware | 7500                        | 7500                        |   |
|                                   |             | Others                | 0                           | 0                           |   |
| Total (Rs.)                       | 65000       |                       | 20000                       | 20000                       |   |

**Total amount for the project: Rs. 105000/-**

The grant is subject to the terms and conditions as mentioned below.

1. A Certificate of Acceptance of the conditions governing the research project should be sent immediately to this office.
2. The amount of the grant shall be drawn by the Accounts Officer (D.D.O), University Grants Commission on the grant-in-aid bill and shall be disbursed to and credited to the above-mentioned institute through D.D./ RTGS Confirmation No/ NEFT/ Transfer No.
3. The sanctioned amount is debatable to the Major Head 4(iv)b(For General), 1.B(i)h(i)b (For SC), 1.B(i)h(i)b (For ST) and is valid for payment during the financial year 2012 -2013 only.
4. The grant is subject to adjustment on the basis of Utilization Certificate in prescribed proforma submitted by University/College/Institute.

**NOTE:**

1. The grant shall not be used self-financial/ non-grant/unaided courses & teachers.
2. Date of implementation will be the date of sanction of first installment.
3. The researcher is required to submit an Acceptance Certificate of the project in the enclosed format to the affiliating university, which would then be sent to UGC (WRO) in a bunch by the University.

4. Please send one copy of the project completion report to Director, INFLIBNET, Gujarat University Campus, Navrangpura, Ahmedabad for record.
5. The statement of expenditure incurred and brief academic progress report relating to the above project is to be sent in the prescribed format to this office after completion of one year. Audited utilization certificate of full-allocated amount, audited statement of expenditure and final project report be submitted immediately after completion of the project.
6. The assets acquired wholly or substantially out of UGC grant shall not be disposed off or encumbered or utilized for purposes other than those for which the grant was given, without proper sanction of the UGC, Western Regional Office, Pune- 07 and should at any time the college cease to function, such assets shall revert to U.G.C.
7. A register of the assets acquired wholly or substantially out of the grant shall be maintained by the University/College in the prescribed form.
8. The University/College shall strictly follow all the instructions issued by the Govt. of India from time to time with regard to reservation of posts for SC/ST/OBC.
9. The interest earned by the University/College/Institute will be treated as additional grant and it is required to be incorporated in the U.C./Statement of Expenditure submitted to UGC, (WRO).
10. The University/College shall fully implement the office Language Policy of the Union Govt. and comply with the official Language Act, 1963 and Official language (use for official purposes of the Union) Rules, 1976 etc.
11. The sanction issues in exercise of the delegation of powers vide Commission office order No.5/92 dated may 01, 1992.
12. The funds to the extent are available under the scheme.
13. The grantee institution shall ensure the Utilization of grants-in-aid for which it is being sanctioned /paid. In case non-utilization/ part utilization, **simple interest @ 10% per annum** amended from time to time on unutilized amount from the date draw/to date of refund as per provisions contained in general financial Rules of Govt. of India will be charged.

Yours faithfully,

(Dr. G. Srinivas)  
Joint Secretary

15/12/17

Copy to:

1. THE PRINCIPAL  
SHRI SHIVAJI COLLEGE, AKOT ROAD , AKOLA -444 003.
2. MR. WAJIRE G. S., SHRI SHIVAJI COLLEGE AKOT ROAD, , AKOLA -  
444 003.
3. DIRECTOR (BCUD), SANT GADGE BABA AMRAVATI UNIVERSITY,  
AMRAVATI, AMRAVATI- 444602
4. DIRECTOR, HIGHER EDUCATION, CENTRAL BLDG, PUNE
5. ACCOUNTANT GENERAL, MAHARASHTRA STATE, MUMBAI
6. GUARD FILE.

(Dr. G. Srinivas)  
Joint Secretary



Shri Shivaji Education Society, Amravati.  
**Shri Shivaji College of Arts, Commerce & Science, Akola**

Near Shivaji Park, Akola - 444 003

**(NAAC Re-Accredited Grade 'A' with CGPA-3.11)**

**UGC Status of College with Potential for Excellence**

Email - shivajiakola@dataone.in & principal@shivajiakola.org Web site : www.shivajiakola-org  
Ph./FAX (0724) - (O) 2433438, (R) 2453295

Dr. Panjabrao  
Deshmukh  
Founder President

Adv. Arunbhai Shell  
President

Dr. S. G. Bhadange  
Principal

Index No.  
In College : 01.01.004  
In College : 205

Ref. No. SSC / AKL /

Date:- 20/07/2015

To,  
The Joint Secretary,  
University Grants Commission,  
Western regional Office,  
Ganeshkhind, Pune- 411007.

**Subject : Release of Rs. 20,000/- towards the expenditure incurred under M.R.P.**

**Reference:** UGC letter File No. : 47- 025/12(PRO), dated 25/02/2013

Respected Sir,

Vide subject cited above, you are requested to release the amount of Rs. 20,000/- towards the expenditure incurred under MRP of Mr. G. S. Wajire of this college. The total amount sanctioned for the MRP was Rs. 1,05,000/-. Out of this, the amount of Rs. 85,000/- was released as a first installment. Till the completion of the study, the total expenditure incurred was Rs. 1,07,833/-. Hence it is requested to sanction the same.

The details of the expenditure are given as below.

| S.No. | Items   | Amount Approved (Rs.) | Expenditure Incurred (Rs.) |
|-------|---|-----------------------|----------------------------|
| I.    | Books & Journals                              | 15,000/-              | 15,149/-                   |
| II.   | Equipment                                     | 50,000/-              | 51,750/-                   |
| III.  | Contingency including special needs           | 10,000/-              | 10,181/-                   |
| IV.   | Field Work/Travel (Give details in proforma ) | 15,000/-              | 15,750/-                   |
| V.    | Hiring Services                               | Nil                   | Nil                        |
| VI.   | Chemicals & Glassware                         | 15,000/-              | 15,003/-                   |
|       | <b>Total =</b>                                | <b>1,05,000/-</b>     | <b>1,07,833/-</b>          |

Kindly send the remaining amount at your earliest.

Thanking you.



o/c

**EXPENDITURE DETAILS**

Name of Investigator :- **Gajanan Shankarrao Wajire** (Asst. Prof. in Electronics)

College Name :- Shri Shivaji College of Art's, Commerce & Science Akola

Date of Starting of Project :- 22/04/2013 and date of Completion of Project :- 22/06/2015

| S.N.                                       | Particulars                       | Bill/Vou. No. | Bill date  | Amount Rs.       |
|--|-----------------------------------|---------------|------------|------------------|
| <b>A) Books &amp; Journals Expenditure</b> |                                   |               |            |                  |
| 1  | Ideal Enterprises, Mumbai         | 01            | 10/08/2013 | Rs. 3817         |
| 2  | Rajarshi Shahu Books, Akola       | 02            | 15/10/2013 | Rs. 2511         |
| 3  | Apana Pustakalaya, Akola          | 03            | 07/08/2013 | Rs. 2921         |
| 4  | Technical Book Services, Poona    | 04            | 20/04/2013 | Rs. 2000         |
| 5  | The Impulse International, Nagpur | 05            | 28/09/2013 | Rs. 3900         |
| <b>Total</b>                               |                                   |               |            | <b>Rs. 15149</b> |
| <b>B) Equipment Expenditure</b>            |                                   |               |            |                  |
| 1  | Mayuree Enterprises, Akola        | 06            | 28/07/2014 | Rs. 14935        |
| 2  | Mayuree Enterprises, Akola        | 07            | 28/02/2014 | Rs. 11365        |
| 3  | R N Electronics, Pusad            | 08            | 02/07/2015 | Rs. 25450        |
| <b>Total</b>                               |                                   |               |            | <b>Rs. 51750</b> |
| <b>C) Contingency Expenditure</b>          |                                   |               |            |                  |
| 1  | Jayantilal Dwakadas Akola         | 09            | 28/05/2013 | Rs. 990          |
| 2  | Sahu Electronics Akola            | 10            | 09/09/2013 | Rs. 985          |
| 3  | Sisodiya Zerox Akola              | 11            | 07/06/2013 | Rs. 180          |
| 4  | Hussaini Shop Akola               | 12            | 30/05/2013 | Rs. 390          |
| 5  | Electronics House Akola           | 13            | 28/05/2013 | Rs. 980          |
| 6  | Jai Ambe Hardwaare Akola          | 14            | 03/05/2013 | Rs. 980          |
| 7  | R N Computers Akola               | 15            | 25/09/2013 | Rs. 990          |
| 8  | Vidarbha Telecoms Akola           | 16            | 22/01/2014 | Rs. 200          |
| 9  | Kailas Mobiles Akola              | 17            | 25/08/2013 | Rs. 930          |
| 10   | Babaji Electronics Akola          | 18            | 10/11/2013 | Rs. 988          |
| 11   | SGB University Amravati           | 19            | 07/06/3014 | Rs. 500          |
| 12   | Laxmi Electronics Akola           | 20            | 31/12/2014 | Rs. 818          |
| 13   | SGB University Amravati           | 21            | 29/11/2014 | Rs. 250          |
| 14   | Science College Nagpur            | 22            | 23/01/2014 | Rs. 1000         |
| <b>Total</b>                               |                                   |               |            | <b>Rs. 10181</b> |
| <b>D) Travel/Field work Expenditure</b>    |                                   |               |            |                  |
| 1  | Akola to Nagpur                   | 23            | 23/01/2014 | Rs. 4760         |
| 2  | Akola to Melghat                  | 24            | 14/03/2014 | Rs. 3270         |
| 3  | Akola to Amravati                 | 25            | 07/06/2014 | Rs. 1930         |
| 4  | Akola to Amravati                 | 26            | 29/11/2014 | Rs. 1930         |
| 5  | Akola to Amravati                 | 27            | 27/10/2014 | Rs. 1930         |
| 6  | Akola to Amravati                 | 28            | 07/02/2015 | Rs. 1930         |
| <b>Total</b>                               |                                   |               |            | <b>Rs. 15750</b> |



| E) Chemicals & Glassware Expenditure |                                   |    |            |                     |
|--------------------------------------|-----------------------------------|----|------------|---------------------|
| 1                                    | Mayuree Enterprises, Akola        | 29 | 28/02/2014 | Rs. 5730            |
| 2                                    | Mayuree Enterprises, Akola        | 30 | 11/03/2014 | Rs. 775             |
| 3                                    | Mayuree Enterprises, Akola        | 31 | 28/07/2014 | Rs. 2950            |
| 4                                    | Swastik Scientifics Akola         | 32 | 28/11/2013 | Rs. 450             |
| 5                                    | Sahu Electronics Akola            | 33 | 13/01/2015 | Rs. 995             |
| 6                                    | Dr. Punjabrao K. Vidyapeeth Akola | 34 | 16/11/2013 | Rs. 100             |
| 7                                    | Goodluck Traders Akola            | 35 | 15/01/2015 | Rs. 787             |
| 8                                    | New Kailas Electronics Amravati   | 36 | 08/02/2015 | Rs. 2980            |
| 9                                    | Supreme Enterprises Akola         | 37 | 15/12/2014 | Rs. 236             |
| <b>Total</b>                         |                                   |    |            | <b>Rs. 15003</b>    |
| <b>Grant Total (A+B+C+D+E) =</b>     |                                   |    |            | <b>Rs.107833 /-</b> |

*[Handwritten Signature]*

Signature of Principal  
(With College Seal)  
**Shri Shivaji College of Arts,  
Commerce & Science, AKOLA  
A Grade C.G.P.A. 3.11, by NAAC**



*[Handwritten Signature]*

Signature of Investigator

*[Handwritten Signature]*

**M. G. CHAWARE**  
CHARTERED ACCOUNTANTS  
M. No. 32803

Signature of Chartered Accountant  
(With seal)



SHRI SHIVAJI COLLEGE OF ART'S, COMMERCE & SCIENCE AKOLA  
LIBRARY DEPARTMENT

Date- 6-5-2014

ACCESSION CERTIFICATE

It is certified that the Books purchased from MRP grant are handed over to the college central library. Their Accession number is from 48425-48463



Investigator

(Asst. Prof. G. S. Wajire)



Librarian  
**LIBRARIAN**

Shri Shivaji College of Arts,  
Commerce & Science, AKOLA




Principal

shri shivaji college, akola  
**PRINCIPAL**  
Shri Shivaji College, of Arts  
Commerce & Science, AKOLA  
A GRADE C.GPA. 3.24., BY NAAG

## ASSETS CERTIFICATE

It is certified that the following Equipments has been handed over to the college.

- 1) CRO- Dual Trace 20 M Hz
- 2) Digital Multimeters
- 3) Currentmeters
- 4) Breadboards
- 5) Voltmeter
- 6) Digital Panelclamp Meter
- 7) 6V/4.5Ah Battery
- 8) Various Electrodes

  
Signature of the Principal

**PRINCIPAL**  
(With Seal of the College)  
**Commerce & Science, AKOLA**  
A Grade C.G.P.A. 3.11, by NAAC



  
Head of Electronics Dept.  
**Shri Shivaji College, Akola**

  
Investigator

  
**M. G. CHAWARE**  
CHARTERED ACCOUNTANT  
M. No. 32803





**UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI - 110 002**

**STATEMENT OF EXPENDITURE IN RESPECT OF MINOR RESEARCH PROJECT**

1. Name of Principal Investigator : Mr. Gajanan Shankarrao Wajire
2. Dept. of Principal Investigator : Department of Electronics,  
Name of the College : Shri Shivaji College, Akola (M.S.) - 444 003.
3. UGC approval Letter No. & Date : 47- 025/ 12(PRO), Date 25/ 02 / 2013
4. Title of the Research Project : DC voltage generation from live plants/trees  
and its utilization in general circuits.
5. Effective date of starting the project : 22<sup>nd</sup> April, 2013
6. a. Period of Expenditure : From April 2013 to June 2015  
b. Details of Expenditure : Details are given as follows

| S.No. | Item   | Amount Approved (Rs.) | Expenditure Incurred (Rs.) |
|-------|--|-----------------------|----------------------------|
| I.    | Books & Journals                                 | 15,000/-              | 15,149/-                   |
| II.   | Equipment  | 50,000/-              | 51,750/-                   |
| III.  | Contingency including special needs              | 10,000/-              | 10,181/-                   |
| IV.   | Field Work/Travel<br>(Give details in proforma ) | 15,000/-              | 15,750/-                   |
| V.    | Hiring Services                                  | Nil                   | Nil                        |
| VI.   | Chemicals & Glassware                            | 15,000/-              | 15,003/-                   |
| VII.  | <b>Total =</b>                                   | <b>1,05,000/-</b>     | <b>1,07,833/-</b>          |

7. If as a result of check or audit objection some irregularity is noticed at later date, action will be taken to refund, adjust or regularize the objected amounts.

8. It is certified that the grant of Rs. 85,000/- (Rupees Eighty Five Thousand only) received from the University Grants Commission under the scheme of support for Minor Research Project entitled " **DC voltage generation from live plants/trees and its utilization in general circuits**" vide UGC letter No. F. 47- 025/ 12(PRO) Dated 25/ 02 / 2013 has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.

*(Signature)*

**M. G. CHAWARE**  
CHARTERED ACCOUNTANTS  
M. No. 32803



*(Signature)*

UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI – 110 002

Annexure - IV

STATEMENT OF EXPENDITURE INCURRED ON FIELD WORK

Name of the Principal Investigator : Mr. Gajanan Shankarrao Wajire

| S.N. | Name of the Place visited                       | Duration of the Visit |            | Mode of Journey | Expenditure Incurred (Rs.) |
|------|---|-----------------------|------------|-----------------|----------------------------|
|      |   | From                  | To         |                 |                            |
| 1.   | Shivaji Science College & Research Lab., Nagpur | 23/01/2014            | 24/01/2014 | Own Car         | 4760 /-                    |
| 2.   | Melghat Forest, Melghat, Tah. - Chikhaldara     | 14/03/2014            | ---        | Own Car         | 3270 /-                    |
| 3.   | Research Lab., SGB University, Amravati         | 07/06/2014            | ---        | Own Car         | 1930 /-                    |
| 4.   | Research Lab., SGB University, Amravati         | 27/10/2014            | ---        | Own Car         | 1930 /                     |
| 5.   | Research Lab., SGB University, Amravati         | 29/11/2014            | ---        | Own Car         | 1930 /                     |
| 6.   | Research Laboratory SSC, Amravati.              | 07/02/2015            | ---        | Own Car         | 1930 /-                    |
|      |   |                       |            | TOTAL =         | 15,750 /-                  |

Certified that the above expenditure is in accordance with the UGC norms for Minor Research Projects.


  
**M. G. CHAWARE**  
CHARTERED ACCOUNTANTS  
M. No. 32803





SIGNATURE OF PRINCIPAL INVESTIGATOR



  
PRINCIPAL  
Shri Shivaji College of Arts,  
Commerce & Science, AKG,  
A Grade C.G.P.A. 3.11, by NAAC

UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI – 110 002

Utilization Certificate


Certified that the grant of Rs. 1,05,000/- (Rupees One Lac Five Thousand only) received from the University Grants Commission under the scheme of support for Minor Research Project entitled "DC voltage generation from live plants/trees and its utilization in general circuits", vide UGC letter File No. : 47-025/12(PRO), dated 25/02/2013 has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.



SIGNATURE OF  
INVESTIGATOR



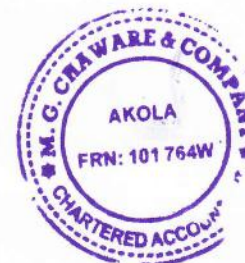
PRINCIPAL  
Shri Shivaji College of Arts  
Commerce & Science, AKOLA  
A Grade C.G.P.A. 3.11, by NAAC



M. G. CHAWARE  
CHARTERED ACCOUNTANTS  
M. No. 32803

STATUTORY AUDITOR

(Seal)



**UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG,  
NEW DELHI – 110002**

**Final Report of the work done on the Major / Minor Research Project  
(Report to be submitted within 6 weeks after completion of each year)**

1. Project Report No. :- 2<sup>nd</sup> (i.e. Final )
2. UGC Reference No. :- 47- 025/ 12(PRO) Date 25/ 02 / 2013
3. Period of report from :- April 2013 to June 2015
4. Title of research project :- DC voltage generation from live plants/trees and its utilization in general circuits.
5. a) Name of the Principal Investigator :- Mr. Gajanan Shankarrao Wajire  
b) Dept. and College where work has progressed :- Department of Electronics, Shri Shivaji College, Akola (M.S.) PIN - 444003.
6. Effective date of starting of the project :- 22<sup>nd</sup> April 2013.
7. Grant approved and expenditure incurred during the period of the report.
  - a) Total amount approved :- Rs. 1,05,000 /-
  - b) Total expenditure :- Rs. 1,07,833 /-

**Report of the work done :-**

**i) Brief objective of the project :-**

- 1) To plan & to decide the range of voltage which is to be generated.
- 2) To design & development of various electrodes & cells (of various shapes & sizes) for tapping the dc voltage.
- 3) To study the effects of different connections and combinations to get the optimum utility of the plant or tree.

ii) **Work done so far and results achieved and publications, if any, resulting from the work ( Give details of papers and names of the journals in which has been published or accepted for publication. :-**

- 1) In order to prepare proper electrodes and cells, different materials like Platinum, Gold, Silver, Copper, Lead, Zink, Aluminum, Ferrous, Carbon and Nickel are studied on the basis of electronic configurations and chemical reactivity.
- 2) Also different type of shapes and sizes of the electrodes of abovementioned materials has been prepared for comparative output response and study.
- 3) The comparative responses of the outputs from the different electrodes and cells (of different sizes), on various types of living plants have taken and the tabulation of the data is done. Also, design and fabrication work of various cells & its analytical testing has done in Central Research Laboratory of Sant Gadgebaba Amravati University, Amravati.
- 4) The output voltages using different electrodes & cells for different living plants are found in the range of 0.35Volts to 1.231 Volts. Using proper combinations of the electrodes & cells, the output voltages ranges to 2.281volts and even more value.
- 5) By connecting the electrodes & cells in particular fashions, the generated output voltage was utilized to operate low voltage electronic circuits such as Quartz Wall Clocks, Digital watches, LED circuits, Calculators, sound/Buzzer circuits and tiny DC motors.

**Paper Published details are :**

- 1) **“Green Electronics: Scope for future renewable energy source ”**  
New Interdisciplinary National Research Journal;  
ISSN : 2279-0349 ; Volume - III, Issue – I, March – 2013.
- 2) **“Green energy can become an alternative low power source”**,  
National Conference on Recent Advances in Electronics and  
Computer Science (NCRAECS) – January, 2014.  
ISBN : 978-81-906457-5-1
- 3) **“Development of Cells for Generation of Potential Difference from Aloe Vera”**, International Journal of Science & Nature ( IJSN);  
ISSN : 2279-6441; IJSN-Vol.5(3) - September, 2014.

iii) **Has the progress been according to original plan of work and towards achieving the objective, if not, state reasons :-**

- iv) **Please enclose a summary of the findings of the study. One bound copy of the final report of work done may also be sent to the concerned Regional Office of the UGC.**

Summary of the findings of the study of this project has been enclosed herewith. Also, one bound copy of the final report of the work done has sent to the concerned Western Regional Office of the UGC at **Pune** branch.

- v) **Any other information:** All the necessary information is already included.



SIGNATURE OF THE PRINCIPAL  
INVESTIGATOR



PRINCIPAL

**PRINCIPAL**  
Shri Shivaji College of Arts,  
Commerce & Science, AKOLA  
A Grade C.GPA. 3.11, by NAAC

**UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG,  
NEW DELHI – 110 002.**

**PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF SENDING THE  
FINAL REPORT OF THE WORK DONE ON THE PROJECT**

1. Title of the Minor Research Project : DC voltage generation from live plants/trees and its utilization in general circuits.
2. NAME AND ADDRESS OF PRINCIPAL INVESTIGATOR : Mr. Gajanan S. Wajire,  
"Vrundavan", Shastrinagar,  
AKOLA (M.S.) - 444 001.
3. NAME AND ADDRESS OF INSTITUTION : Department of Electronics,  
Shri Shivaji College, Akola (M.S.)  
PIN – 444 003.
4. UGC APPROVAL No. AND DATE : 47- 025/ 12(PRO) Date 25/ 02 / 2013
5. DATE OF IMPLEMENTATION : 22<sup>nd</sup> April 2013.
6. TENURE OF THE PROJECT : 2 Years
7. TOTAL GRANT ALLOCATED : Rs. 1,05,000 /-
8. TOTAL GRANT RECEIVED : Rs. 85,000 /-
9. FINAL EXPENDITURE : Rs. 1,07,833 /-
10. TITLE OF THE PROJECT : DC voltage generation from live plants/  
trees and its utilization in general circuits.

11. OBJECTIVES OF THE PROJECT :

- 1) To plan & to decide the range of voltage which is to be generated.
- 2) To design & development of various electrodes & cells (of various shapes & sizes) for tapping the dc voltage.
- 3) To study the effects of different connections and combinations to get the optimum utility of the plant or tree.
- 4) Finally to utilized the generated voltage for actual operation of few low

## 12. WHETHER OBJECTIVES WERE ACHIEVED : (GIVE DETAILS)

Yes, the progress was according to original plan of work and towards achieving the objectives. Finally, the generated voltage was utilized for actual operation of few low voltage electronic circuits and/or gadgets. The output voltage was applied to operate low voltage electronic circuits such as Digital watches, LED circuits, Calculators, Sound/Buzzer circuits, small Toys and tiny DC motors.

## 13. ACHIEVEMENTS FROM THE PROJECT :

The concept of generating the DC voltage (potential difference) from living plants and trees is somewhat creative and innovative. This kind of system could provide low cost, pollution free, continuous & natural option of the electricity or power source, which might be used for different low power applications in near future.

This research work will be useful to understand few electrical, chemical as well as the botanical characteristics of the plants and trees used throughout this work. Though this fundamental & pioneer research work is in its infancy, but it will be helpful to the scientists & researchers for advanced developments & research in this field.

The outcome of the research work is to add and develop the fundamental concepts in the field of electricity generation from plants and trees, which might be utilized in various disciplines in different ways.

## 14. SUMMARY OF THE FINDINGS ( IN 500 WORDS ) :

Detail study on the research topic is done and a separate summary of the project is enclosed with this report.

## 15. CONTRIBUTION TO THE SOCIETY (GIVE DETAILS) :

- The generated voltage has an importance and market value.
- It has more advantageous to layman and/or society, as the plants and trees are easily available throughout the world.
- It may become a cheap and affordable source of low power energy.
- Can generate electricity from plants and trees throughout the farms, gardens, yards or even in pots.
- Also this research work will be helpful to the scientists & researchers for advanced development & research in the related fields.
- As the generation of electricity is from plants and trees, it has the relevance of



16. WHETHER ANY Ph.D. ENROLLED / PRODUCED OUT OF THE PROJECT :

Yes, Ph. D is enrolled out of this project. The principal investigator has registered his Ph. D. in Sant Gadge Baba Amravati University, Amravati (M.S.).

17. NO. OF PUBLICATIONS OUT OF THE PROJECT : 04  
( PLEASE ATTACH DETAILS )

**Paper Published details are :**

- 1) **"Green Electronics: Scope for future renewable energy source "**  
New Interdisciplinary National Research Journal;  
ISSN : 2279-0349 ; Volume - III, Issue – I, March – 2013.
- 2) **"Green energy can become an alternative low power source".**  
National Conference on Recent Advances in Electronics and  
Computer Science (NCRAECS) – January, 2014.  
ISBN : 978-81-906457-5-1
- 3) **"Development of Cells for Generation of Potential Difference from  
Aloe Vera"**, International Journal of Science & Nature ( IJSN);  
ISSN : 2279-6441; IJSN-Vol.5(3) - September, 2014.
- 4) **"Obtaining the Potential Difference from Prickly Pear "**  
INTERNATIONAL JOURNAL OF INFORMATIVE & FUTURISTIC RESEARCH  
(IJIFR); ISSN : 2347-1697 ; IJIFR /VOLUME: E8- May, 2015.

PRINCIPAL INVESTIGATOR  
( Mr. Gajanan S. Wajire )

PRINCIPAL

**PRINCIPAL**  
Shri Shivanji College of Arts,  
Commerce & Science, AKOLA.  
A Grade C. GPA3.11, by NAAC

## Summary of Minor Research Report

Name of the Principal Investigator : - **Gajanan Shankarrao Wajire**  
(Asst. Prof. in Electronics)  
Shri Shivaji College, Akola- 444003.

Title of Minor Research Project : - **DC voltage generation from live plants/trees  
and its utilization in general circuits.**

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### **(1) Introduction :-**

Electrical energy plays a major role in our day-to-day life, due to which its demand and consumption is also increasing consistently. As a result, different ways of electricity generation are being tested & introduced. Almost all the methods of generation used are categorized as conventional energy and non-conventional (renewable) energy types. Due to the more uses of conventional type, there are many environmental problems, which has to be faced in the practical life. So, in order to overcome most of these problems, different non-conventional energy sources are being developed and used. Through this minor project, an impact is given to generate DC voltage from succulent type of plant like Aloe Vera or Cactus group of plants. This is a type of non-conventional energy & is very useful as it is eco-friendly technique of voltage generation.

As per the law of conservation of energy, "Energy can neither be generated nor destroyed, but can be converted from one form to another". The non-conventional energy sources such as solar energy, wind energy, hydro energy, tidal energy & biogas energies are playing important role in the global demand because conventional energy sources are exhausting rapidly due to enormous uses & consumptions. At present, the scientists are doing endeavor efforts to find out various non-conventional energy sources which could replace the present conventional energy sources. There are number of ways by which electricity is being produced. Producing the electricity from tree's or plant's leaf as well as stem is possible. During the process of photosynthesis, each cell of the leaf emits trillions of electrons. By the proper movement & collection of these electrons, we can produce small amount of electricity. In another method, we can get current from leafs by means of flow of electrons between two types of different plants using different metal conductors, cells or sensors. If the researcher are able to produce or generate electricity from plants or trees, everyone wants to be planting the trees in ones garden. Governments of different countries also motivated such a process of plantation. So, the number of trees in the globe will also be increase, whereby the earth can even save from global warming by the process of plantation.

The present scientific world is taking much effort to explore the non-conventional energy sources for the development of the growing humankind. Therefore, the current minor research project in science urge the evolution of renewable and non-conventional energy resources. This project describes the design aspect of one such non-conventional low power energy sources in which various plant or trees are used separately as an electrolyte with the help of different electrodes and cells.

## (2) Few reviews from research teams :

**MIT research team** : MIT researchers now believe they can power a network of sensors connected directly to trees to perform a variety of tasks. "A new sensor system is under development that runs on electricity generated by ordinary trees! Apparently trees are capable of self-sustaining a reliable source of electricity. While a tree may not seem like much of a powerhouse, the "trickle charge" can add up, "just like a dripping faucet can fill a bucket over time," said Shuguang Zhang, one of the researchers on the project and the associate director of MIT's Center for Biomedical Engineering (CBE).

Trees could serve as "silent sentinels" along the nation's borders to detect potential threats such as smuggled radioactive materials with the sensors powered by the trees themselves. They could also prevent forest fires, among other applications, by sending early reports to the authorities.

**U.S. Forest Service** : Right now, the U.S. Forest Service says that manually recharging or replacing batteries in remote automated weather stations, which usually have to be located in hard-to-reach places, makes things impractical and costly. The new sensor system would bypass this problem by tapping into trees as it's very own self-sustaining power supply. Each sensor is equipped with an off-the-shelf battery that can be slowly recharged using electricity generated by the tree itself.






The system produces enough electricity to allow the temperature and humidity sensors to wirelessly transmit signals four times a day, or immediately if there's a fire. Each signal hops from one sensor to another, until it reaches an existing weather station that beams the data by satellite to a forestry command center in Boise.

**Wageningen UR plant scientists** : It is possible to use plants for generating energy without first having to harvest them. This is the exiting conclusion after Wageningen UR plant scientists and environmental technologists connected reed grass to a microbial fuel cell. This fascinating discovery could open the door to numerous new applications.

"It is indeed very green energy and in principle far more efficient than energy from biomass," says Jan Snel, photosynthesis expert at Plant Research International and Wageningen UR Greenhouse Horticulture, and a team member involved with this research project from the onset. "It is more efficient because you stay much closer to the source. We use relatively simple organic acids and sugars that are produced by the plants with the aid of sunlight and which partly are naturally secreted through their roots. Those acids and sugars are broken down by bacteria and we harvest the electrons released in the process. In principle, this allows energy to be generated day and night". David Strik of the Environmental Technology group is equally enthusiastic. "Although we are currently talking about very small amounts of energy, the crucial thing is that we have proof of principle. In near future we can produce power from plants .

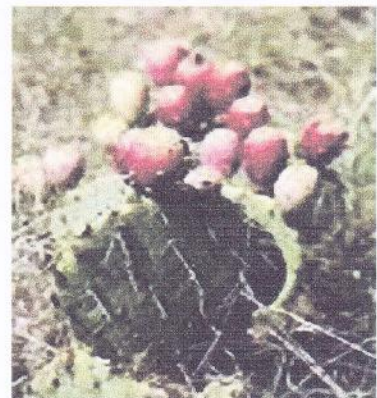
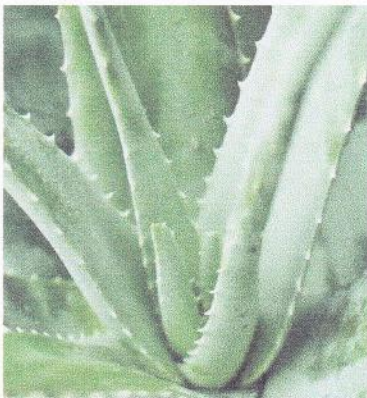
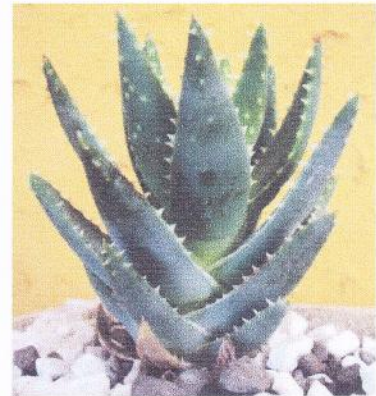
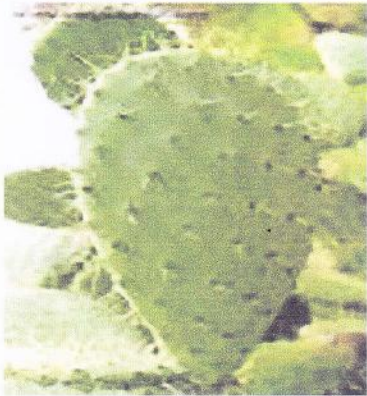
## (3) Classification of Plants :

The undertaken research involves several steps for generation of optimum voltage (potential difference). This includes the classification of plants for the stipulated purpose. In general all the plants are classified in following types:

-  Ficus
-  Cactus
-  Almus
-  Pinus
-  Acer

### Few Cactus plant photographs

Throughout this minor research project, some electrical, chemical & botanical features of these plants will also be studied. Few cactus plant images are shown below :



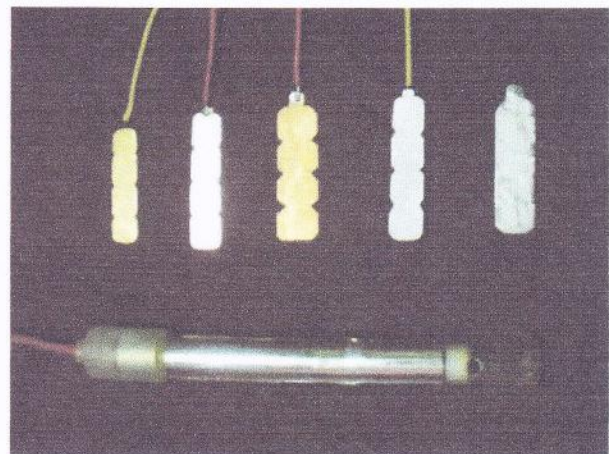
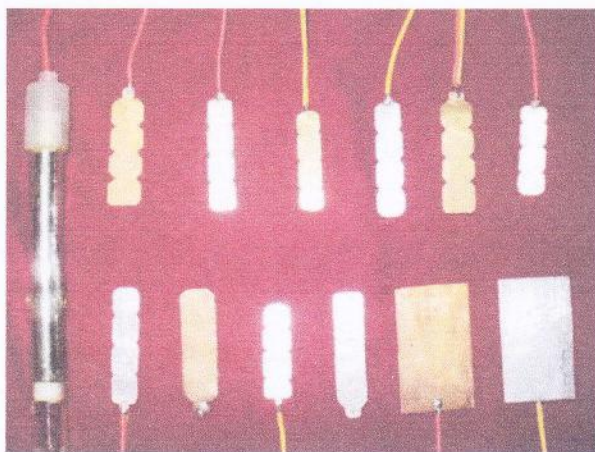
#### (4) Why "Cactus" genus is selected ?

- Easily available throughout the world.
- Cheap and affordable.
- Can grow in farms, gardens, yards or even in pots.
- Not consumed by animals, pets or human beings.
- More succulent plant with long life.
- Can live in extreme environmental conditions.
- Large surface area of leaves.
- Large amount of swap flow.
- Contains large amount of Carbon dioxide ( $\text{CO}_2$ ), Oxygen ( $\text{O}_2$ ), Hydrogen (H), Glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ), Plastoquinone ( $\text{PQH}_2$ ), Ferredoxin, Carbohydrates, Minerals, Water ( $\text{H}_2\text{O}$ ) etc.
- Less corrosive for electrodes or cells.
- Photosynthesis process taken place on large extent (day & night).

#### **(5) Materials used for construction of Electrodes & cells :**

Electrodes & cells of different materials has been designed and developed of various sizes & shapes. Responses of various plants & trees for different types of electrodes & cells has been studied. Also, a response of various plants & trees has been studied for electrodes of different sizes & shapes. Following materials are used to designed and developed the electrodes and cells of various sizes & shapes.

- Copper Electrodes
- Aluminum Electrodes
- Zink Electrodes
- Lead Electrodes
- Iron Electrodes
- Silver Electrodes
- Gold Electrodes
- Tungsten Electrodes
- Platinum Electrodes
- Carbon Electrodes & Bimetallic Electrodes



Photographs : Different electrodes and few cells designed

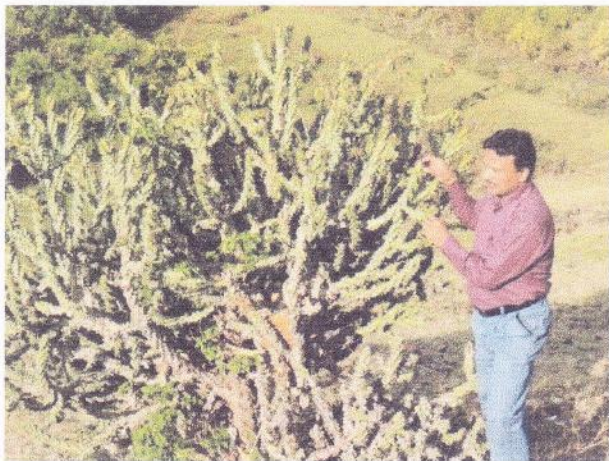
#### **(6) Responses of plants in different environmental conditions :**

All possible environmental conditions of the plant has been studied and tested for different combinations of electrodes for maximum efficiency of voltage generation. Following are few environmental situations/conditions, during which the response was studied.

- During the rainy season
- During the winter season
- During the summer season
- During the day time
- During the night time

#### **(7) Samples of plants collected from :**

During the undertaken minor research project, the samples of plants for the data collections were procured from different locations. Few locations along with the titles are shown in following photographs.



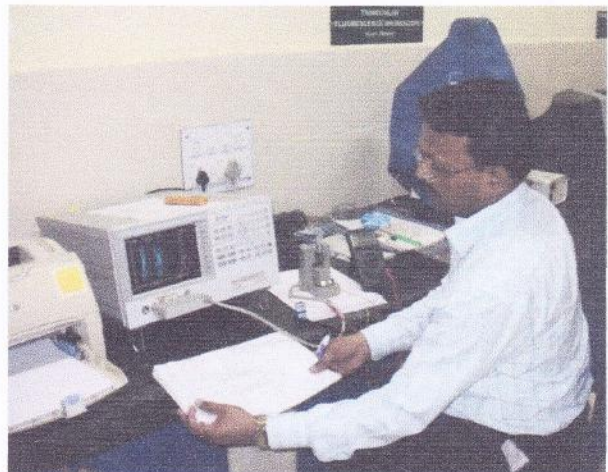
1) Euphorbia plant: sample collected from **Melghat forest, Chikhaldara, Dist. – Amravati.**



2) Prickly Pear plant: sample collected & tested From **Morna river, Bhod, Dist. – Akola.**



3) Sample being tested at **College Research Laboratory, Akola** using CRO & DMM.



4) Sample being tested at **SGB University Research Laboratory, Amravati** using Impedance Analyzer & DMM



5) Sample collection by investigator from **Lonar Lake, Dist. – Buldhana**



6) **Prickly Pear** plant with Zn-Al electrodes indicating **1.288V** output on DMM

### (8) Measurement of Electrical Parameters :

For the optimum range of output voltage and current, various combinations like series combination, parallel combination, anti-series and anti-parallel combinations of electrodes and cells has been tested and studied for different plants. Using Platinum & Zink electrode pair (Pt-Zn), the optimum single pair output voltage was recorded as 1.510 volts where as two series combinations of Platinum – Zink (Pt-Zn) pairs output was recorded more than 2.481 volts.

The 4294A, Precision Impedance Analyzer, is an integrated instrument for efficient impedance measurements and analysis of electronic components and circuits. The Platinum-Zink (Pt-Zn) cell was analyzed using Precision Impedance Analyzer (Model : 4294A M/S Agilent, USA), at “Instrumentation and Research Center” of Sant Gadge Baba University Amravati. Various electrical parameters like impedance, resistance, capacitance, conductance, output voltage, output current and output power were measured for analysis before and after the insertion of cell into the Aloe vera plant. These observations are briefly summarized in table I below.

Table (1) : Measurement of Electrical parameters

| S. N. | Electrical Parameters | Before Cell insertion | After Cell insertion |
|-------|-----------------------|-----------------------|----------------------|
| 1     | Impedance (Z)         | High (M $\Omega$ )    | Low (m $\Omega$ )    |
| 2     | Conductance (G)       | Low ( $\mu$ S)        | High (mS)            |
| 3     | Resistance (R)        | High (K $\Omega$ )    | Low (m $\Omega$ )    |
| 4     | Capacitance (C)       | Low (pF)              | High (nF)            |
| 5     | Output Voltage (V)    | 0.00 Volt             | 0.967 Volt           |
| 6     | Output Current (I)    | 0.00 mA               | 9.5 m Amp            |
| 7     | Output Power (P)      | 0.00 mW               | 9.18 m Watt          |

The observed output current is considered as short circuit current which is practically proportional to the corresponding potential difference or emf. Similarly, the potential difference, which is nothing but the output voltage and it is considered as open circuit voltage.

### (9) Utilization of output voltage in miniature electronic circuits :

After successful generation of small amount of potential difference, it was utilized for actual working of miniature electronic circuits and gadgets. With the help of proper combinations of electrodes and cells, following electronic circuits were operated by using this output voltage.

- Quartz Wall Clocks
- Calculators with LCD Display
- Tiny DC Motors
- Digital Watches
- Small Toys and Gadgets
- LED Circuits
- Small Torches & so on

The output voltages of different cells using different plants/trees are summarized as follows:

| S.N. | Name of the Plant/Tree          | Pt - Zn Cell | Ag - Zn Cell | Cu - Zn Cell | Cu - Al Cell | Au - Zn Cell |
|------|---------------------------------|--------------|--------------|--------------|--------------|--------------|
| 1)   | Prickly Pear                    | 1.510V       | 1.445V       | 1.056V       | 0.860V       | 1.070V       |
| 2)   | Aloe Vera<br>(Aloe Barbadensis) | 1.223V       | 1.225V       | 0.964V       | 0.770V       | 1.231V       |
| 3)   | Musa<br>Paradisica              | 0.845V       | 1.082V       | 0.815V       | 0.594V       | 0.851V       |
| 4)   | Michelia<br>Champaca            | 0.962V       | 1.026V       | 0.838V       | 0.660V       | 0.886V       |
| 5)   | Euphorbia<br>Nerripholia        | 0.867V       | 1.003V       | 0.884V       | 0.655V       | 0.928V       |
| 6)   | Ficus<br>Glomarata              | 0.689V       | 0.712V       | 0.815V       | 0.613V       | 0.820V       |
| 7)   | Ficus<br>Benghalensis           | 0.586V       | 0.592V       | 0.742V       | 0.589V       | 0.793V       |
| 8)   | Calotropis<br>Gigantia          | 0.512V       | 0.540V       | 0.591V       | 0.506V       | 0.584V       |

Apart from these major findings, there are some observations :

- 1) There is reciprocal relation between electrodes distance and output voltage & current.
- 2) There is positive relation between electrodes surface area and output voltage & current.
- 3) Insignificant variation in results according to the seasons of the year.
- 4) Series and shunt combinations of the cells can be used to increase output voltage & current.
- 5) Predominantly the series combination increases the voltage level while the shunt combination increases the current level.
- 6) Zink electrode works as good cathode (negative) terminal for almost all combinations.
- 7) Due to redox reactions, Aluminum and Zink materials oxidizes on some extent.
- 8) The output voltage appears across the cell for long span of time.
- 9) Electrodes and cells are more active and sensitive to succulent plants/trees.
- 10) Proper combinations of the cells can be used for working of miniature electronic circuits.



### **(8) Measurement of Electrical Parameters :**

For the optimum range of output voltage and current, various combinations like series combination, parallel combination, anti-series and anti-parallel combinations of electrodes and cells has been tested and studied for different plants. Using Zink & Aluminum electrode pair (Zn-Al), the optimum single pair output voltage was recorded as 1.231 volts where as two series combinations of Platinum – Zink (Pt-Zn) pairs output was recorded more than 2.281 volts.

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Table (2) : Measurement of Electrical parameters

| S. N. | Electrical Parameters | Before Cell insertion | After Cell insertion |
|-------|-----------------------|-----------------------|----------------------|
| 1     | Impedance (Z)         | High (M $\Omega$ )    | Low (m $\Omega$ )    |
| 2     | Conductance (G)       | Low ( $\mu$ S)        | High (mS)            |
| 3     | Resistance (R)        | High (K $\Omega$ )    | Low (m $\Omega$ )    |
| 4     | Capacitance (C)       | Low (pF)              | High (nF)            |
| 5     | Output Voltage (V)    | 0.00 Volt             | 0.967 Volt           |
| 6     | Output Current (I)    | 0.00 mA               | 9.5 m Amp            |
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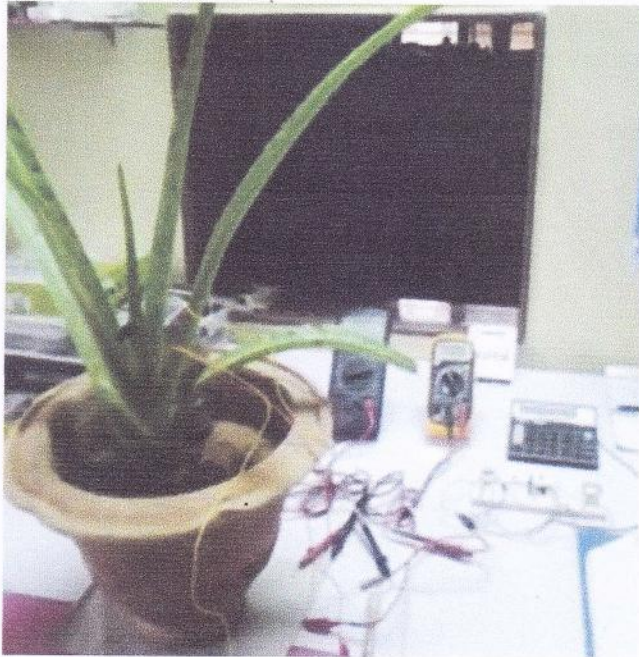
The observed output current is considered as short circuit current which is practically proportional to the corresponding potential difference or emf. Similarly, the potential difference, which is nothing but the output voltage, is considered as open circuit voltage.

### **(9) Utilization of output voltage in miniature electronic circuits :**

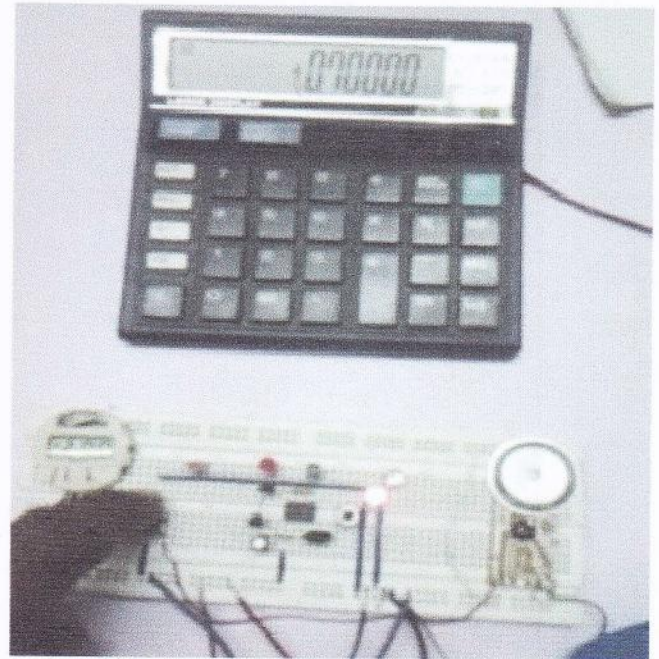
After successful generation of small amount of potential difference, it was utilized for actual working of miniature electronic circuits and gadgets. Using proper combinations of electrodes and cells, the following electronic circuits were operated by this output voltage.

- Quartz Wall Clocks
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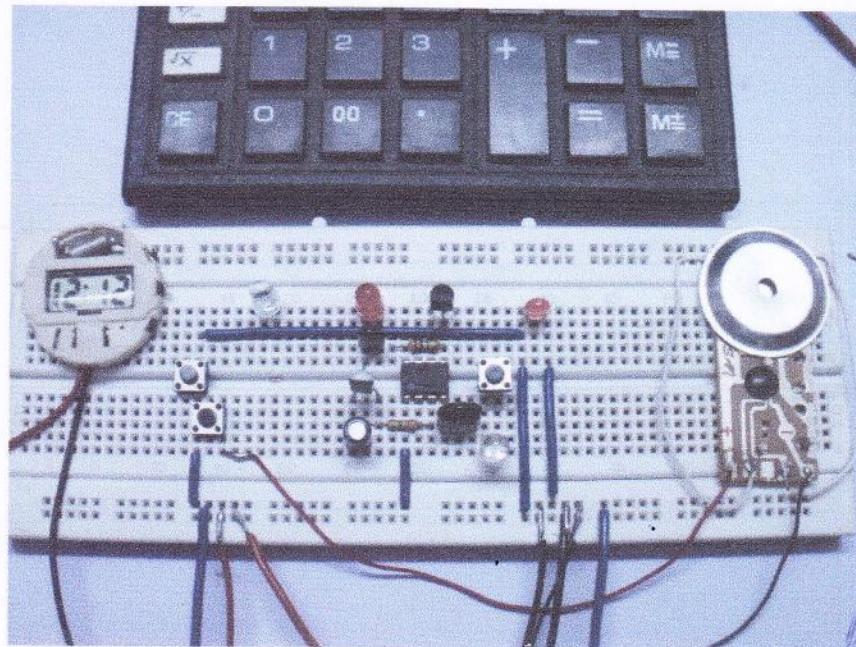
Actual photographs and video clips of actual operation of above miniature electronic circuits and gadgets are recorded and stored in the research laboratory of the college. More and more applications of this generated potential difference are being tested and studied till the date, for its optimum utilization. The efforts are being made that how it can be used more effectively for the general social approach and common laymen.



1) Normal Setup using Aloe Vera plant



2) Calculator, Digital Clock & LED are in working



3) Sound/Buzzer circuit, Digital clock & IC 555 circuit in working condition

Large number of photographs and video clips of actual operation of above miniature electronic circuits and gadgets are recorded and stored in the research laboratory of the college. More and more applications of this generated potential difference are being tested and studied, for its optimum utilization. The efforts are being made that how it can be utilized more effectively for general social approach and common laymen. This is a type of non-conventional energy & is very useful as it is eco-friendly technique of low voltage generation.