Sahyadri Shikshan Mandal's

Mahant Jamanadas Maharaj

Arts, Commerce and Science College

Karanjali, Tal. Peth, Dist. Nashik – 422208, (MS) India

(Affiliated to Savitribai Phule Pune University, Pune)

Accredited by NAAC- 'C' Grade (CGPA-1.72)

Criterion-III:

Research, Innovations and Extension

3.5.: Collaboration

3.5.1: Number of functional MoUs/linkages with institutions/ industries in India and abroad for internship, on-the-job training, project work, student/ faculty exchange and collaborative research during 2018-19 to 2022-23

॥ स्वदेशे पुज्यते राजा विन्दान्सर्वत्र पुज्यते ॥
Govt. of Mah. Order No. N.G.C. 2009 (152/09) MS R - 4
Sahyadri Shikshan Mandal's Dindori
Mahant Jamanadas Maharaj
ARTS, COMMERCE & SCIENCE COLLEGE
ID No. PU/NS/ACS/150/2009
Karanjali, Tal. Peth, Dist. Nashik. (Maharashtra) 422 208. Ph.No.: 02558 - 234666
E-mail : mjmcollege1@yahoo.com College Code - 908

जावक क्र.: 186/2024-25 दिनांक : 20/12/2024

DECLARATION

This is to declare that the information, reports, true copies of the supporting documents, numerical data etc. submitted / Presented in the files is verified by Internal Quality Assurance Cell (IQAC) and it is correct as per the record.

This declaration is for the purpose of NAAC accreditation of HEI for the 2nd cycle period 2018-2019 to 2022-23.

Date:-20/12/2024

Place:-Karanjali

Dr.M.S.Shinde
I.Q.A.C. Co-ordinator
M.J.M. Arts, Commerce and Science College
Karanjali, Nashik-422 208

M.J.M. A.C. & S. College Karajali Tal.Peth, Dist.Nashik

Dr.U.P.Shinde
Principal
M.J.M. Arts, Commerce & Science College Karajali, Tal.Peth, Dist.Nashik

Sahyadri Shikshan Mandal,
Karanjali, Tal.: Peth, Dist.: Nashik.
Pin : 422 208, Ph.: 02558 234666 / +91 9420002030

Table of Contents

QnM - 3.5.1: The number of functional MoUs/linkages with institutions/ industries in India and abroad for internship, on-the-job training, project work, student/ faculty exchange and collaborative research during 2018-19 to 2022-23

Mahant Jamanadas Maharaj College of Arts, Commerce and Science, Karanjali, Tal-Peth, Dist-Nashik, Maharashtra State, is providing education to one and all belonging to this tribal area in the form of various graduate, postgraduate and other career oriented certificate program to fulfill the needs of tribal youths who are diversified in their previous knowledge and learning abilities. The main motto of the collaboration and linkages is to provide the suitable platform to the students, teachers and researchers to collaborate with specific activities. The collaboration are sign in view to provide the necessary facilities in development of the institution and personal development of the teachers and stakeholders. College has identified the areas of development of students and taken initiatives to prepare them to accept the challenges of 21st century as well as to achieve the goals of higher education. In context of this, IQAC along with all academic departments proactively involved in establishing linkages, collaborations and MoU's. The efforts made by the institute in tune with the perspective plan are noteworthy and established 32 collaborations and signed 32 MoU's for developing the various skills among students such as life, communication, research, employability as well as to provide the employment and learning opportunities. The activities are conducted to achieve the learning experiences in various areas along with teaching-learning process. These activities largely supported to maintain the learning ambience at institute. As an outcome of these activities the student strength is found to be continuously increasing during last five years. Faculties have conducted joint projects and published the good number of research articles in journals of repute. By collaborating with nearby institutions and research center we have published more than 40 research papers and

other student development, enrichment programs and quality programs have been conducted through collaborations.

3.5.1. Total Number of MOU during 2018-19 to 2022-23

Total Number of MOU during 2018-19 to 2022-23: 32

Year	2022-23	2021-2022	2020-2021	2019-2020	2019-2018	Total
Number of MOU	16	09	03	03	02	33

Activities List: MoU

Sr. No.	Name of the MoU / Collaboration / Linkage	Name of the Collaborating agency / Institution/ Industry/ Corporate House with whom the MoU/ Collaboration / Linkage is made with contact Details	Year of signing MoU's/ Collaboration / Linkage	Duration of MoU's/ Collaboration / Linkage	List the actual activities under each MoU's and web links year wise	Number of Activity
2022-23						
1.	Om Foods And Nturals	Om Foods And Nturals	2022	5	One Day Workshop on Spirulina	1
2.	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	2021	10	Guest Lecture	1
3.	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	2021	10	Students Training	1
4.	Department of Botany Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji	Department of Botany Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji	2022	6	Resource Person in One Day Workshop and Research	2

	Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar			Publication	
5.	Department of Chemistry Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Chemistry Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2022	6	Guest Lecture	1
6.	Department of Physics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Physics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2022	6	Guest Lecture	1
7.	Department of Mathematics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Mathematics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2022	6	Guest Lecture	1
8.	Department of Zoology Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji	Department of Zoology Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji	2022	6	Guest Lecture	1

	Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar				
9.	Gokhule Education Socitey's HPT Arts and RYK Science College, Nashik, Maharashtra-422005.	Gokhule Education Socitey's HPT Arts and RYK Science College, Nashik, Maharashtra-422005.	2021	6	Guest Lecture in Workshop	1
10.	Shri.Neminath Jain Brahmacharyaashram, Karmaveer K.H.Abad Arts Shriman M.G.Lodha Commerce and Shriman P.H.Jain Science College, Neminagar, Chandwad,Dist-Nashik, Maharashtra-423101.	Shri.Neminath Jain Brahmacharyaashram, Karmaveer K.H.Abad Arts Shriman M.G.Lodha Commerce and Shriman P.H.Jain Science College, Neminagar, Chandwad,Dist-Nashik, Maharashtra-423101.	2022	6	Students Participated in Workshop	1
11.	Deola Education Society Karmveer Ramraoji Aher Arts Science and Commerce College Deola Tal.Deola Dist Nashik	Deola Education Society Karmveer Ramraoji Aher Arts Science and Commerce College Deola Tal.Deola Dist Nashik	2022	1	Research Paper	1
12	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	2020	5	Research Paper	1
13	Mahatma Gandhi Vidyamandirs Arts Sciences and Commerce College Manmad Nashik	Mahatma Gandhi Vidyamandirs Arts Sciences and Commerce College Manmad Nashik	2022	5	Research Paper	1

14	Department of Zoology Iqra's H.J.Thim College of Arts and Science Mehrun Jalgaon Maharashtra	Department of Zoology Iqra's H.J.Thim College of Arts and Science Mehrun Jalgaon Maharashtra	2022	5	Patent Published	1
15	Social and Cultural Association Smt.Narmadbai Nago Chaudhari Arts Commerce and Science College Kasumba Dhule,424302.	Social and Cultural Association Smt.Narmadbai Nago Chaudhari Arts Commerce and Science College Kasumba Dhule,424302.	2022	5	Research Paper	1
16	Nandurbar Taluka Vidhayak Samiti's G.T.Patil Arts Commerce and Science College Nandurbar Maharashtra 425412	Nandurbar Taluka Vidhayak Samiti's G.T.Patil Arts Commerce and Science College Nandurbar Maharashtra 425412	2023	5	Patent Published	1
2021-22						
1	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	2021	10	Guest Lecture	1
2	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	2021	10	Students Training	1
3	Department of Botany Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Botany Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2021	6	Research Paper Publication (Collaboration)	3

4	Department of Chemistry Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Chemistry Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2021	6	Guest Lecture	1
5	Department of Physics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Physics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2021	6	Guest Lecture	1
6	Department of Mathematics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Mathematics Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2021	6	Guest Lecture	1
7	Department of Zoology Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	Department of Zoology Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar	2021	6	Guest Lecture	1

8	Gokhule Education Socitey's HPT Arts and RYK Science College, Nashik, Maharashtra-422005.	Gokhule Education Socitey's HPT Arts and RYK Science College, Nashik, Maharashtra-422005.	2021	6	Guest Lecture in Workshop	1
9	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	2020	5	Research Paper	1
2020-21						
1	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	2018	5	Guest Lecture	1
2	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	2018	5	Students Training	1
3	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	2020	5	Research Paper	1
2019-20						
1	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	2018	5	Guest Lecture	1
2	Shri.Dnayaneshwa	Shri.Dnayaneshwa	2018	5	Students	1

	r Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	r Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar			Training	
3	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	Department of Chemistry of Karmveer Abasaheb Alias N.M.Sonawane Arts Commerce and Science College Satana District Nashik	2020	5	-	-
2018-19						
1	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	Jijamata College of Science and Arts Bhende Tal-Newasa Dist-Ahmednagar	2018	5	Guest Lecture	1
2	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	Shri.Dnayaneshwar Sahakari Sakhar Karakhana Ltd. Bhende Tal-Newasa Dist-Ahmednagar	2018	5	Students Training	1

Nandurbar Taluka Vidhayak Samiti's
G. T. PATIL ARTS, COMMERCE & SCIENCE COLLEGE, NANDURBAR
Linguistic Minority Institute, Affiliated to KBC NMU, Jalgaon
NAAC Re-accredited 'B+' Grade (3rd Cycle-CGPA-2.73), ISO 9001:2015 Certified
Excellent College Award 2014 of KBCNMU, Jalgaon
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02564 - 222293
Shahi Mahidir Road, Tal. Dist. Nandurbar - 425412 (M.S.)

OW. No.: GTPC/ Date : 07/02/2023

Memorandum of Understanding (MOU)

Between

Sahyadri Shikshan Mandal's,
Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali

&

Nandurbar Taluka Vidhayak Samiti's
G. T. Patil Arts, Commerce and Science College, Nandurbar, Maharashtra-425412.

This document constitutes a Memorandum of Understanding (MOU) between **Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208** and **Nandurbar Taluka Vidhayak Samiti's G. T. Patil Arts, Commerce and Science College, Nandurbar Maharashtra - 425412 on 7th February, 2023.**

1. Aim of this MOU:

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures. Vide this MOU both parties agree to the same with mutual consent.

2. Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

- Internship
- Industrial visits
- Knowledge sharing
- Joint research and publications
- Resources sharing and exchange

3. This MOU shall be effective only after Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208 and Nandurbar Taluka Vidhayak Samiti's G. T. Patil Arts, Commerce and Science College, Nandurbar Maharashtra-425412 on 7th February, 2023., mutually agree on the terms & conditions.

4. General Terms Of MOU:

a) ***Duration of MOU:*** This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 30th September 2027. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

b) ***Coordination:*** In order to carry out and fulfill the aims of this MOU, each party is to appoint an appropriate person(s) to represent its organization and coordinate the implementation of activities. Full names, designations, Mobile numbers, and Email IDs of such persons will be incorporated in this MOU.

c) ***Financial Implementations:*** There is no financial cost or liability whatsoever involved in this MOU from both parties. No right/title/interest in any manner will be created in the either of the college properties and, or, otherwise by anybody. There will be no financial burden upon the parties under the MOU as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student and teacher benefit at large.

d) ***Confidentiality:*** Each party agrees that it shall not, at any time, after executing the activities of this MOU, will disclose any information without mutual consent.

e) ***Termination of MOU:*** This MOU can be terminated at any time with one month prior written notice to each other by both parties without assigning any reason.

f) ***Extension of MOU:*** This MOU will be further extendible by one year, at the mutual consent of both parties on further mutually agreed terms.

g) ***Communications:*** All parties' communications shall be done by Email, or ordinary post. Only in case of termination of MOU communication will be done by Email followed by Registered Post A/D to the other party.

h) ***Addendum:*** Any addendum to this MOU shall be in writing & signed by both parties.

Herewith both parties confirm that provisions in this MOU do not go against the rules and regulations of the Government policies.

Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties here to have executed this MOU till 30th September 2027

Dr. M. S. Shinde Principal M.J.M. Arts, Commerce & Science College, Karanjali, Tal. Peth, Dist. Nashik	**Dr. G. H. Balde** Head Research and P. G. Dept of Zoology
Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208.	Nandurbar Taluka Vidhayak Samiti's G. T. Patil Arts, Commerce and Science College, Nandurbar, Maharashtra-425412
Coordinator **Dr. Prakash Tanaji Wankhedkar** Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208. Mobile No:-+91-9422144082 Email:-avinashjondhale51@gmail.com	**Coordinator** **Dr. D. S. Patil** Nandurbar Taluka Vidhayak Samiti's G. T. Patil Arts, Commerce and Science College, Nandurbar Maharashtra -425412 Mobile No:-+91-8975533440 Email:- patildhananjay2007@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. D. T. Tayde	2) Dr. N. P. Huse
3) Dr Gori Niranjan	4) Dr. B. B. Chaudhari

Memorandum of Understanding (MOU)

Between

Sahyadri Shikshan Mandal's,

Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali

&

Department of Zoology,

Iqra's H. J. Thim College of Arts and Science Mehrun, Jalgaon, Maharashtra-425001.

Memorandum of Understanding (MOU)
Between
Sahyadri Shikshan Mandal's,
Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali
&
Department of Zoology,
Iqra's H. J. Thim College of Arts and Science Mehrun, Jalgaon, Maharashtra-425001.

This document constitutes a Memorandum of Understanding (MOU) between **Department of Zoology, Iqra's H. J. Thim College of Arts and Science Mehrun, Jalgaon, Maharashtra-425001on 3rd August, 2022.**

1. ***Aim of this MOU:***

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures. Vide this MOU both parties agree to the same with mutual consent.

2. Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

Internship

Industrial visits

Knowledge sharing

Joint research and publications

Resources sharing and exchange

3) This MOU shall be effective only after Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208 and

Department of Zoology, Iqra's H. J. Thim College of Arts and Science Mehrun, Jalgaon, Maharashtra-42500, mutually agree on the terms & conditions.

4. General Terms of MOU:

4a) Duration of MOU: This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 30th September 2027. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

4b)Coordination: In order to carry out and fulfil the aims of this MOU, each party is to appoint an appropriate person(s) to represent its organization and coordinate the implementation of activities. Full names, designations, Mobile numbers, and Email IDs of such persons will be incorporated in this MOU.

4c) Financial Implementations: There is no financial cost or liability whatsoever involved in this MOU from both parties. No right/title/interest in any manner will be created in the either of the college properties and, or, otherwise by anybody. There will be no financial burden upon

the parties under the MOU as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student and teacher benefit at large.

4d) Confidentiality: Each party agrees that it shall not, at any time, after executing the activities of this MOU, will disclose any information without mutual consent.

4e) Termination of MOU: This MOU can be terminated at any time with one month prior written notice to each other by both parties without assigning any reason.

4f) Extension of MOU: This MOU will be further extendible by one year, at the mutual consent of both parties on further mutually agreed terms.

4g) Communications: All parties' communications shall be done by Email, or ordinary post. Only in case of termination of MOU communication will be done by Email followed by Registered Post A/D to the other party.

4h) Addendum: Any addendum to this MOU shall be in writing & signed by both parties. Herewith both parties confirm that provisions in this MOU do not go against the rules and regulations of the Government policies.

Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties hereto have executed this MOU till 30th September 2027

Dr. M. S. Shinde **Principal** Principal M.J.M. Arts, Commerce and Science College Karanjali-422208	Prof. I. M. Pinjari **Incharge Principal**
ahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208.	**Iqra's H. J. Thim College of Arts and Science Mehrun, Jalgaon, Maharashtra-42500**
Coordinator Dr. Prakash Tanaji Wankhedkar **Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208.** Mobile No:-+91-9422144082 Email:-avinashjondhale51@gmail.com	**Coordinator** Dr. Yusuf Ebrahim Patel **Department of Zoology, Iqra's H. J. Thim College of Arts and Science Mehrun, Jalgaon, Maharashtra-42500** Mobile No:-+91-9270121864 Email:- yusufpatel70@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. A.S. Jondhale	3) Dr. Hafiz Mahmad Shaikh Date: 03/08/2022
2) Dr. Niranjan R. Gaikwad	4) Dr. Tanveer Akhtar Khan Date: 03/08/2022

Social & Cultural Association's

Smt. Narmadabai Nago Chaudhari
Arts, Commerce & Science College,
Kusumba Tal & Dist. Dhule. (02560) 270242

NAAC ACCREDITED "B+" GRADE

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Memorandum of Understanding (MOU)
Between
Sahyadri Shikshan Mandal's,
Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali
&
Social and Cultural Association's,
Smt. Narmadabai Nago Chaudhari Arts, Comm. & Science College Kusumba, Tal. & Dist. Dhule, Maharashtra-424302.

This document constitutes a Memorandum of Understanding (MOU) between **Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208** and **Social and Cultural Association's, Smt. Narmadabai Nago Chaudhari Arts, Comm. & Science College, Kusumba, Tal. & Dist. Dhule, Maharashtra-424302 on 17th November, 2022.**

1. Aim of this MOU:

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures. Vide this MOU both parties agree to the same with mutual consent.

2. Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

Internship
Industrial visits
Knowledge sharing
Joint research and publications
Resources sharing and exchange

3) This MOU shall be effective only after Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208 and

Social and Cultural Association's, Smt. Narmadabai Nago Chaudhari Arts, Comm. & Science College Kusumba, Tal. & Dist. Dhule, Maharashtra-424302, mutually agree on the terms & conditions.

4. General Terms Of MOU:

4a) Duration of MOU: This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 30th September 2027. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

4b) Coordination: In order to carry out and fulfill the aims of this MOU, each party is to appoint an appropriate person(s) to represent its organization and coordinate the implementation of activities. Full names, designations, Mobile numbers, and Email IDs of such persons will be incorporated in this MOU.

4c) Financial Implementations: There is no financial cost or liability whatsoever involved in this MOU from both parties. No right/title/interest in any manner will be created in the either of the college properties and, or, otherwise by anybody. There will be no financial burden upon the parties under the MOU as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student and teacher benefit at large.

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4e) Termination of MOU: This MOU can be terminated at any time with one month prior written notice to each other by both parties without assigning any reason.

4f) Extension of MOU: This MOU will be further extendible by one year, at the mutual consent of both parties on further mutually agreed terms.

4g) Communications: All parties' communications shall be done by Email, or ordinary post. Only in case of termination of MOU communication will be done by Email followed by Registered Post A/D to the other party.

4h) Addendum: Any addendum to this MOU shall be in writing & signed by both parties.

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Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties hereto have executed this MOU till 30th September 2027

Dr.M.S.Munde Principal M.J.M. Arts, Commerce and Science College, Karanjali, Nashik-422 208 Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208.	Dr. S.G. Bavistar I/c. Principal Smt. Narmadabai Nago Chaudhari Arts, Com. & Sci. College Kusumba. Pin-424302 Tal. Dist. Dhule (M.S.) Social And Cultural Institute Smt. Narmadabai Nago Chaudhari Arts, Comm. & Science College Kusumba, Tal. & Dist. Dhule, Maharashtra-424302

Coordinator Dr. Prakash Tanaji Wankhedkar Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208. Mobile No:-+91-9422144082 Email:- avinashjondhale51@gmail.com	**Coordinator** Dr. Hasim M. Shaikh Social and Cultural Association's, Smt. Narmadabai Nago Chaudhari Arts, Comm. & Science College Kusumba, Tal. & Dist. Dhule, Maharashtra-424302 Mobile No:-+91-9404745939 Email:- contacthsk@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. Siddharth Bhaskar Sonawane	2) Dr. Milind Sitaram Jondhale
3) Dr. A. S. Jondhale	4) Dr. Kiranjan. R. Gi

Memorandum of Understanding (MOU)
Between
Mahatma Gandhi Vidyamandirs Arts, Science and Commerce, college Manmad
&
Sahyadri Shikshan Mandal's,
Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali

This document constitutes a Memorandum of Understanding (MOU) between Mahatma Gandhi Vidyamandirs Arts, Science and Commerce, college Manmad and Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208 on 29th September 2022

1. ***Aim of this MOU:***

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures. Vide this MOU both parties agree to the same with mutual consent.

2. Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

Internship
Industrial visits
Knowledge sharing
Joint research and publications
Resources sharing and exchange

3) This MOU shall be effective only after Mahatma Gandhi Vidyamandirs Arts, Science and Commerce, college Manmad and

Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208, mutually agree on the terms & conditions.

4. General Terms Of MOU:

4a) Duration of MOU: This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 30th September 2027. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

4b)Coordination: In order to carry out and fulfill the aims of this MOU, each party is to appoint an appropriate person(s) to represent its organization and coordinate the implementation of activities. Full names, designations, Mobile numbers, and Email IDs of such persons will be incorporated in this MOU.

4c)Financial Implementations: There is no financial cost or liability whatsoever involved in this MOU from both parties. No right/title/interest in any manner will be created in the either of the college properties and, or, otherwise by anybody. There will be no financial burden upon the parties under the MOU as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student and teacher benefit at large.

4d) Confidentiality: Each party agrees that it shall not, at any time, after executing the activities of this MOU, will disclose any information without mutual consent.

4e)Termination of MOU: This MOU can be terminated at any time with one month prior written notice to each other by both parties without assigning any reason.

4f) Extension of MOU: This MOU will be further extendible by one year, at the mutual consent of both parties on further mutually agreed terms.

4g)Communications: All parties' communications shall be done by Email, or ordinary post. Only in case of termination of MOU communication will be done by Email followed by Registered Post A/D to the other party.

4h)Addendum: Any addendum to this MOU shall be in writing & signed by both parties.

Herewith both parties confirm that provisions in this MOU do not go against the rules and regulations of the Government policies.

Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties hereto have executed this MOU till 30th September 2027

Dr.M.S.Shinde Principal	Dr.A.V.Patil PRINCIPAL Arts, Sci. & Comm. College MANMAD, Dist. Nashik
Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208.	Mahatma Gandhi Vidyamandirs Arts, Science and Commerce, college Manmad
Coordinator Dr. Avinash S.Jondhale Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208. Mobile No:-+91-9422144082	Coordinator Dr. Rahul A.Shinde Mahatma Gandhi Vidyamandirs Arts, Science and Commerce, college Manmad Mobile No:-+91-9284611286
Witnesses: Full Name, Signature, Date	
1) Dr. Giri Niranjan Ramesh	2) Mr. R. S. Shinde
3) Dr. Prakash Tanaji Wankhedkar	4) Mr. Milind A. Nagare

भारतीय गैर न्यायिक

एक सौ रुपये Rs. 100

रु. 100 ONE HUNDRED RUPEES

सत्यमेव जयते

भारत INDIA

INDIA NON JUDICIAL

महाराष्ट्र MAHARASHTRA ◑ 2022 ◑ 1.8AA 687695

अनुक्रमांक 2992 रुपये १०० दिनांक ६/९/२०२२

श्री. एन. जे. एच. महाविद्यालय करंजाली तर्फे

हस्ते श्री. प्रा. पी. देपाक नोंदवत तर्फे

श्री. एच. पी. गवळी
स्टॅम्प वेंडर, तहसिल कचेरी पेठ,
परवाना क्र. १००/२००२

SUB TREASURY OFFICE
Peth, Dist. Nashik
27 SEP 2022
SUB TREASURY OFFICER
Peth

Memorandum of Understanding (MOU)

Between

Sahyadri Shikshan Mandal's,
Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali
&
Shri. Neminath Jain Brahmacharyashram,
Karmaveer K. H. Abad Arts, Shriman M. G. Lodha Commerce & Shriman P.H. Jain Science College, Neminagar, Chandwad, Dist-Nashik, Maharashtra-423101.

This document constitutes a Memorandum of Understanding (MOU) between Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208 and Shri. Neminath Jain Brahmacharyashram, Karmaveer K. H. Abad Arts & Shriman M. G. Lodha Commerce & Shriman P.H. Jain Science College, Neminagar, Chandwad, Dist-Nashik, Maharashtra-423101 on 29th September 2022

1. ***Aim of this MOU:***

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures. Vide this MOU both parties agree to the same with mutual consent.

2.Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

Internship

Industrial visits

Knowledge sharing

Joint research and publications

Resources sharing and exchange

3) This MOU shall be effective only after Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208 and

Shri. Neminath Jain Brahmacharyashram, Karmaveer K. H. Abad Arts &Shriman M. G. Lodha Commerce &Shriman P.H. Jain Science College, Neminagar, Chandwad, Dist-Nashik, Maharashtra-423101,mutually agree on the terms & conditions.

4. General Terms Of MOU:

4a)Duration of MOU: This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 30th September2027. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

4b)Coordination: In order to carry out and fulfill the aims of this MOU, each party is to appoint an appropriate person(s) to represent its organization and coordinate the implementation of activities. Full names, designations, Mobile numbers, and Email IDs of such persons will be incorporated in this MOU.

4c)Financial Implementations: There is no financial cost or liability whatsoever involved in this MOU from both parties. No right/title/interest in any manner will be created in the either of the college properties and, or, otherwise by anybody.There will be no financial burden upon the parties under the MOU as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student and teacher benefit at large.

4d)Confidentiality: Each party agrees that it shall not, at any time, after executing the activities of this MOU, will disclose any information without mutual consent.

4e)Termination of MOU: This MOU can be terminatedat any time with one month prior written notice to each other by both parties without assigning any reason.

4f) Extension of MOU: This MOU will be further extendible by one year, at the mutual consent of both parties on further mutually agreed terms.

4g)Communications: All parties' communicationsshall be done by Email, or ordinary post. Only in case of termination of MOU communication will be done by Email followed by Registered Post A/D to the other party.

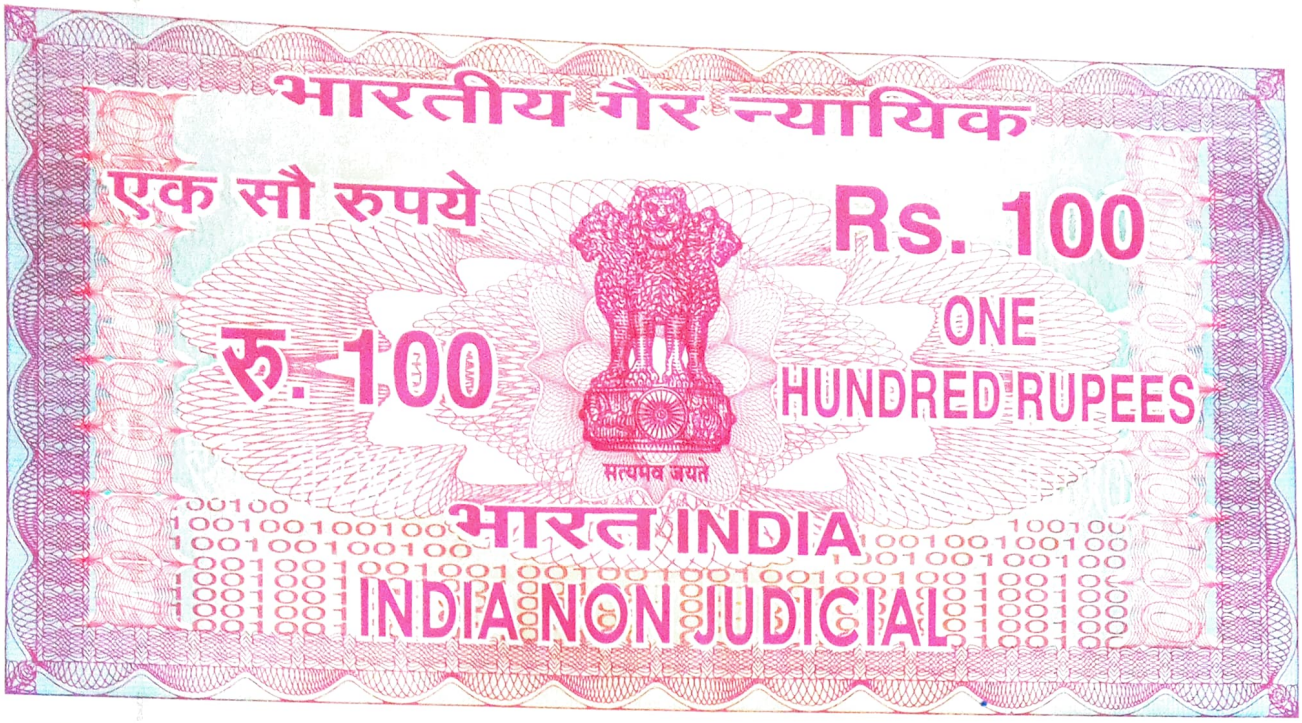
4h)Addendum: Any addendum to this MOU shall be in writing & signed by both parties.

Herewith both parties confirm that provisions in this MOU do not go against the rules and regulations of the Government policies.

Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties hereto have executed this MOU till 30th September 2027

Dr.M.S.Shinde Principal Principal M.J.M. Arts, Commerce and Science College Karanjali, Nashik-422 208	Dr.G.H.Jain Principal PRINCIPAL SNJB's K.K.H.A.Arts, S.M.G.L. Commerce & S.P.H.J. Science College Chandwad-423 101 Dist-Nashik
Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208.	**Shri. Neminath Jain Brahmacharyashram, Karmaveer K. H. Abad Arts &Shriman M. G. Lodha Commerce &Shriman P.H. Jain Science College, Neminagar, Chandwad, Dist-Nashik, Maharashtra-423101**
M. J. M. COLLEGE KARANJALI TAL. PETH, DIST. NASHIK	SNJB's K.K.H.A.Arts, S.M.G.L. Commerce & S.P.H.J. Science College CHANDWAD (NASHIK)
Coordinator Dr.AvinashS.Jondhale **Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208.** Mobile No:-+91-9422144082 Email:-avinashjondhale51@gmail.com	**Coordinator** Dr. Manoj T.Patil **Shri. Neminath Jain Brahmacharyashram, Karmaveer K. H. Abad Arts &Shriman M. G. Lodha Commerce &Shriman P.H. Jain Science College, Neminagar, Chandwad, Dist-Nashik, Maharashtra-423101** Mobile No:-+91-7588797522 Email:- manojtpatil@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. Chavan Smita. P. 29-09-2022	2) Dr Sudhir C. Dalale 29/09/2022
3) Dr. Rohit Madhukar Nikam 29/09/2022	4) Dr. R.S. Sancheti 29/09/2022



महाराष्ट्र MAHARASHTRA ◑ 2021 ◑ YY 849981

अ. क्र. ४५ रूपये १०० दि. ५/१/२०२२
श्री/सौ. M.J.M. Art's, Comm. & Sci. College Karanjali, Tal.: Peth (Nasik)
रा.: ताड वकी
हस्ते : अरुण

M. J. M. COLLEGE KARANJALI TAL. PETH DIST. NASHIK

श्री. पी. झेड. कोळी १९५/२००३
स्टॅम्प वेंडर, तहसिल कार्यालय, पेठ

SUB TREASURY OFFICER

MEMORANDUM OF UNDERSTANDING

This memorandum of understanding (MOU) here in after referred to as the memorandum entered into on March 2022,by and between **OM FOODS AND NTURALS** residing at **Jorve** road **Sangamner**,here in after referred to as First Party ,and **Sahyadri Shikshan Mandal's, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali, Tal-Peth, Dist-Nashik**, here in after referred to as Second Party.

Objectives:-

I- This MOU states that, we do not have collaboration for any economic benefits.

II- To inculcate skill of identifying herbal products ,their quality ,skill ofmarketing ,production etc.

III- Under PMKVY students can establish their own startup.

IV- This activity will be voluntary for the collegestudents.

This agreement shall be signed by **OM FOODS AND NATURALS** and **Sahyadri Shikshan Mandal's, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali, Tal-Peth, Dist-Nashik** shall be effective from March 2022. Duration – Five years(2022to 2027)

Responsibilities of the Parties:

i) Both the parties agree that, in order to execute this MoU, there are existing agreements neither any third party will enter in to this MoU.

1. **Confidentiality:**
   I. The Parties agree to maintain strict secrecy and confidentiality regarding any and all Confidential Information exchanged or to be exchanged between them in relation to thisAgreement.
   II. The parties agree to restrict access and disclosure of Confidential Information to such of their employees, agents, vendors and contractors strictly on a 'need to know' basis to maintain confidentiality of the Information disclosed to it in accordance with thisclause.

IN WITNESS WHEREOF, the parties here to have put their hands and seals on the date, month and the year mentioned above.

First Party

OM FOODS AND NATURALS

Managing Director
Mrs. Sujata S. Mandlik
(MSc. (Botany)
Om Foods & Naturals

Second Party

Principal
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

M.J.M. COLLEGE KARANJALI TAL. PETH DIST. NASHIK

Witness:

Om Foods & Naturals Fassai Lic No. 21521151001117 Ozar, Dist. Nashik

Witness:

Head
Department of Botany
MJM Arts Commerce and Science College
Karanjali

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (here in after referred as the "MoU" is made and executed on this 01st Day of July 2022 at Karanjali Maharashtra.

BETWEEN

Mahant Jamanadas Maharaj Arts, Commerce and Science College, Karanjali, Tal. Peth, District. Nashik – 422208, Maharashtra State, India.

Through its Head, Dept. of Physics
(Here in referred as First Party)
AND

Deola Education Society's Karmveer Ramraoji Aher Arts, Science & Commerce College Deola Tal. Deola, Dist. Nashik. Maharashtra State, India.

Through its Head, Dept. of Physics
(Here in referred as Second Party)

The expressions "First Party" and "Second Party" Shall collectively be referred to as 'Parties' and individually as "Party"

WHEREAS:

A) First Party – Established in 2009 by Sahyadri Shikshan Mandal's (Dindori), Mahant Jamanadas Maharaj Arts, Commerce and Science College, Karanjali, Tal. Peth, District. Nashik – 422208, Maharashtra State, India. with the objective of providing higher education to the tribal youths from remote areas, affiliated to Savitribai Phule Pune University.

B) Second Party – Established in 1978 by Deola Education Society's Karmveer Ramraoji Aher Arts, Science & Commerce College Deola Tal. Deola, Dist. Nashik. Maharashtra State, India, with objective of sculpturing youths by carving with higher education, is one of the best recognized college affiliated to Savitribai Phule Pune University, Pune.

C) The First Party and Second Party have expressed willingness to share knowledge and Human Resources (Teaching Staff) concerned with Physics Department of both the parties on the terms and conditions set out here in below;

IT IS AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Purpose/Objective of the MOU:

OBJECTIVES:

i) Explore and share Physics instrumentation, Research and Laboratory Service.

ii) The strive for greater, excellence in higher education to improve the efficiency of teaching as well as learning of both the parties.

iii) To exchange subject information and to share infrastructure facilities for the purpose of teaching subject of both the parties.

iv) As knowledge feast to organize guest lectures for students of both the parties.

v) Guidance to the students regarding projects and seminars for empowerment of the students towards Excellence with scientific cultures and skills of both the parties.

vi) To develop Research skill among students and teaching staff of both the parties.

vii) Prof. Rajendra Gunjal, Head, Department of Physics, Deola Education Society's Karmveer Ramraoji Aher Arts, Science & Commerce College Deola Tal. Deola, Dist. Nashik. Maharashtra State, India, from Party 2: concerned with the completion of this MoU with respect to the above Objective.

2. Responsibilities of the Parties:

i) The First Party and Second Party will prepare a manual to guide the institute for accreditation.

ii) Both the parties agree that, in order to execute this MoU, there are existing agreements neither any third party will enter in to this MoU.

3. **Term of Agreement:**
The term of this MoU is for one year commencing from 1st Day of July 2022. The term can be extended up to two years after prior agreement of both and approval from University Grants Commission, New Delhi.

4. **Confidentiality:**

I. The Parties agree to maintain strict secrecy and confidentiality regarding any and all Confidential Information exchanged or to be exchanged between them in relation to this Agreement.

II. The parties agree to restrict access and disclosure of Confidential Information to such of their employees, agents, vendors and contractors strictly on a 'need to know' basis to maintain confidentiality of the Information disclosed to it in accordance with this clause.

a. Information and material disclosed and provide by each party to the other party in pursuance of or in connection with performance of its obligation under this agreementshall at all times remain the soul and exclusive property of the disclosing party.

2. Dispute Settlement:

Any dispute arising between the parties in connection with or arising out of the performance of mutual obligations under this MoU shall be resolved by mutual discussion and consultation. If the dispute remains even after 30 days, then dispute shall be referred to Dr. Mahendra Shinde, Head, Dept. of Physics, Mahant Jamanadas Maharaj Arts, Commerce and Science College, Karanjali (Peth) Dist. Nashik. Maharashtra State, India, and Prof. Rajendra Gunjal, Head, Dept. of Physics, Deola Education Society's Karmveer Ramraoji Aher Arts, Science & Commerce College Deola Tal. Deola, Dist. Nashik. Maharashtra State, India, The arbitrator decision of Both the Heads of the Parties shall be final and binding on both parties.

IN WITNESS WHEREOF, the parties here to have put their hands and seals on the date, month and the year mentioned above.

For Dept. of Physics, Mahant Jamanadas Maharaj Arts, Commerce and Science College, Karanjali(Peth), Dist. Nashik. Maharashtra State, India,

Name: Dr. Mahendra Shinde
Designation: Head, Dept. of Physics

Head
Dept. of Physics
M.J.M.Art's Comm.& Sci.College
Karanjali Tal Peth (Nashik)

Witness:

1)Name: Dr. A. S. Jondhale
Designation: Head,Dept of Botany

2)Name: Dr.D.T.Tayde
Designation: Head,Dept of Chemistry

For, Deola Education Society's Karmveer Ramraoji Aher Arts, Science & Commerce College Deola Tal. Deola, Dist. Nashik. Maharashtra State, India,

Name: Prof. Rajendra Gunjal
Designation: Head, Dept. of Physics

HEAD
Department of Physics
K.R.A. Arts,Science and Comm. College
Deola,Tal.Deola (Nashik)

Witness:

1)Name: Dr. S.B. Bansode.
Designation: Coordinator, IQAC

Co-Ordinator,IQAC
K.R.A.A.S.C.College Deola,Nashik

2)Name: Prof. Tushar Wagh.
Designation: Assi Professor

महाराष्ट्र MAHARASHTRA ◑ 2023 ◑ 99603 60AA 346391

मुद्रांक विक्री बाबतची नोंद वही अनुक्रमांक दिनांक 13/9/2023

प्रतिज्ञापत्रासाठीचे कारण ---

मुद्रांक विकत घेणाऱ्याचे नांव व रहिवासी पत्ता मा. प्राचार्य एस. एम. बी. एस. टी. कॉलेज, संगमनेर

हस्ते असल्यास नाव व पत्ता हस्ते: अमित पचपिंड रा. कनकापूर

मुद्रांक विकत घेणाऱ्याची सही

परवानाधारक मुद्रांक विक्रेत्याची सही

व परवानाधारक तसेच मुद्रांक विक्रीचे ठिकाण/पत्ता- श्री.नितीन भिवाजी कुमठेकर (मु.वि.प.क्र.१०४७१/९८) १६३५, विश्वास झेरॉक्स, संगमनेर

उपकोषागार कार्यालय, संगमनेर
पुरस्कृत दिनांक
05 SEP 2023
उपकोषागार अधिकारी, संगमनेर

Memorandum of Understanding (MOU)

Between

S.B.V.P.Samaj's

Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, Ahmednagar Pin. 422605

&

Sahyadri Shikshan Mandal's,

Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali Tal. Peth Nashik, 422208

This document constitutes a Memorandum of Understanding (MOU) betweenS.B.V.P. SAMJ'S SahakarMaharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, Ahmednagar & Mahant Jamanadas Maharaj, Arts Commerce and Science College, Karanjali, Maharashtra- 422208 on 15th. September 2023.

1. ***Aim of this MOU:***

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures.Vide this MOU both parties agree to the same with mutual consent.

2.Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

- Internship
- Industrial and Field visits
- Knowledge sharing
- Joint research and publications
- Resources sharing and exchange
- Organization workshops, seminars and Conferences

3) This MOU shall be effective only after S.B.V.P. SAMJ'S Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, Ahmednagar

And

Sahyadri Shikshan Mandal's,MahantJamanadasMaharaj, Arts Commerce And Science College, Karanjali, Maharashtra- mutually agree on the terms & conditions.

4. General Terms Of MOU:

4a) Duration of MOU: This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 30th August2028. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

4b) Coordination: In order to carry out and fulfil the aims of this MOU, each party is to appoint an appropriate person(s) to represent its organization and coordinate the implementation of activities. Full names, designations, Mobile numbers, and Email IDs of such persons will be incorporated in this MOU.

4c) Financial Implementations: There is no financial cost or liability whatsoever involved in this MOU from both parties. No right/title/interest in any manner will be created in the either of the college properties and, or, otherwise by anybody.There will be no financial burden upon the parties under the MOU as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student and teacher benefit at large.

4d) Confidentiality: Each party agrees that it shall not, at any time, after executing the activities of this MOU, will disclose any information without mutual consent.

4e) Termination of MOU: This MOU can be terminatedat any time with one month prior written notice to each other by both parties without assigning any reason.

4f) Extension of MOU: This MOU will be further extendible by one year, at the mutual consent of both parties on further mutually agreed terms.

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4h) Addendum: Any addendum to this MOU shall be in writing & signed by both parties.

Herewith both parties confirm that provisions in this MOU do not go against the rules and regulations of the Government policies.

Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties hereto have executed this MOU till 14th Sept. 2028

Dr.Ugalal P.Shinde **Principal** **M.J.M. Arts, Commerce and Science College** Karanjali, Nashik-422 208	Dr.Dinanath D.Patil Principal Sahakar Maharshi Bhausaheb Santuji Thorat College of Art's, Science & Commerce Sangamner- 422 605
Dr.Avinash S.Jondhale **Coordinator** **Sahyadri Shikshan Mandal's, Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208.** Mobile No:-+91-9422144082 Email:-avinashjondhale51@gmail.com	**Dr.Balasheb D.Wagh** **Coordinator** **S.B.V.P. Samaj's SahakarMaharshiBhausahebSantujiThorat College of Arts, Science & Commerce, Sangamner, Ahmednagar,Maharashtra-422605** Mobile No:-+91-9922190906 Email:- balasaheb.wagh1@gmail.com
Witnesses: Full Name, Signature, Date	
1) Prof. T.C. Gaikwad	2) Dr. M.M. Sakalkale
3) Dr. N.R. Gir	4) V.R (Prof:- V.R. Pandle)

महाराष्ट्र MAHARASHTRA ◑ 2023 ◑ · 60AA 448559

उपकोषागार कार्यालय, संगमनेर
पुरवठा दिनांक
03 OCT 2023
उपकोषागार अधिकारी, संगमनेर

मुद्रांक विक्री व नोंदवही अनुक्रमांक ११७०९
दि 05 OCT 2023
प्रतिज्ञापत्र कोणाकडे सादर करावयाचे ----------
दस्तांचा प्रकार ----------
दस्त नोंदणी करणार आहात का ----------
मिळकतीचे वर्णन ----------
मुद्रांक विक्त घेणार मा.प्रा.स.म.घा.सं.यो. महाविद्या. संगमनेर ह.व्ही.एस.गुंजाळ
निमज
सही Gunjal

दुस-या पक्षकाराचे नाव -------
मुद्रांक शुल्क रक्कम --------
परवानाधारक क्र.विक्रेत्याचे नाव/पत्ता
संगमनेर वकील संघ मर्या. संगमनेर
श्री. संजय बाबुराव भंडारी
(मु.वि.प.क्र.एस.टी.पी/एस.व्ही.एस.एस./५२६५/२००४)
सही ----------

Memorandum of Understanding (MOU)

Between

S.B.V.P.Samaj's

Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, Ahmednagar Pin. 422605

&

Sahyadri Shikshan Mandal's,

Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali Tal. Peth Nashik, 422208

M. B. S. T. Sangamner COLLEGE

This document constitutes a Memorandum of Understanding (MOU) between S.B.V.P. SAMJ'S SahakarMaharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, Ahmednagar & Mahant Jamanadas Maharaj, Arts Commerce and Science College, Karanjali, Maharashtra- 422208 on 05th October 2023.

1. ***Aim of this MOU:***

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures.Vide this MOU both parties agree to the same with mutual consent.

2. Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

- Internship
- Industrial and Field visits
- Knowledge sharing
- Joint research and publications
- Resources sharing and exchange
- Organization workshops, seminars and Conferences.

3) This MOU shall be effective only after S.B.V.P. SAMJ'S Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, and Ahmednagar

And

Sahyadri Shikshan Mandal's,MahantJamanadasMaharaj, Arts Commerce And Science College, Karanjali, Maharashtra- mutually agree on the terms & conditions.

4. General Terms of MOU:

4a) Duration of MOU: This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 30th September 2028. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

4b) Coordination: In order to carry out and fulfill the aims of this MOU, each party is to appoint an appropriate person(s) to represent its organization and coordinate the implementation of activities. Full names, designations, Mobile numbers, and Email IDs of such persons will be incorporated in this MOU.

4c) Financial Implementations: There is no financial cost or liability whatsoever involved in this MOU from both parties. No right/title/interest in any manner will be created in the either of the college properties and, or, otherwise by anybody. There will be no financial burden upon the parties under the MOU as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student and teacher benefit at large.

4d) Confidentiality: Each party agrees that it shall not, at any time, after executing the activities of this MOU, will disclose any information without mutual consent.

S.M.B.S.T. Sangamner COLLEGE

4e) Termination of MOU: This MOU can be terminated at any time with one month prior written notice to each other by both parties without assigning any reason.

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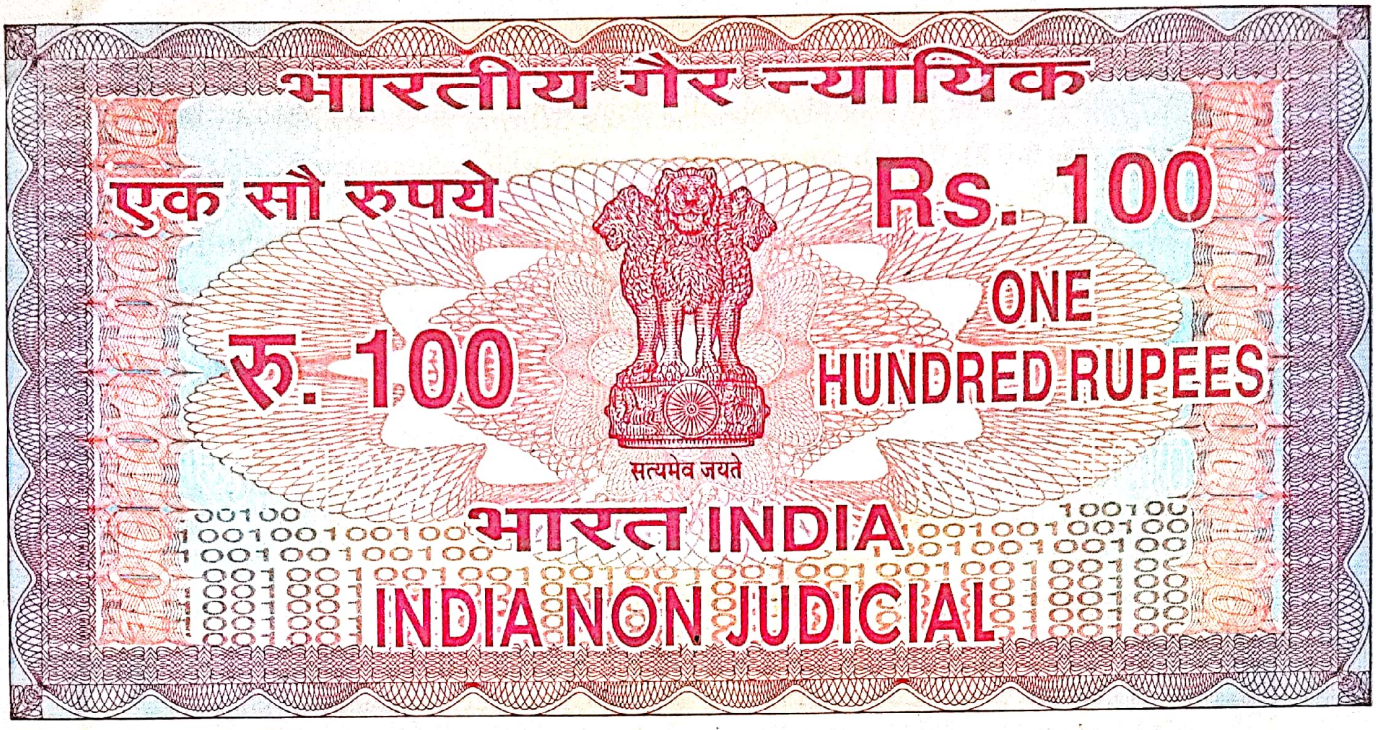
Herewith both parties confirm that provisions in this MOU do not go against the rules and regulations of the Government policies.

Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties hereto have executed this MOU till 30th September 2028

Dr.Ugalal P.Shinde **Principal** **M.J.M. Arts, Commerce and Science College** Kasanjali, Nashik-422 208	Dr.Dinanath D.Patil **Principal** **S.M.B.S.T. College Sangamner**
Dr.Deepak Totaram Tayde Coordinator (H.O.D.Dept.of Chemistry) Sahyadri Shikshan Mandal's, Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208. Mobile No:-+91-9421983158 Email:-dtt_chem@yahoo.com	Dr.Shobha Sakharam Borhade Coordinator (H.O.D.Dept.of Chemistry) S.B.V.P. Samaj's Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, Ahmednagar,Maharashtra-422605 Mobile No:-+91-9960872151 Email:- borhadeshobha@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. Rohit M. Nikam. 05/10/2023	2) Dr. B. D. Waigh. 05/10/2023
3) Dr. R. H. Waghchaure	4) (Prof. V. L. Pande) 5/10/2023



महाराष्ट्र MAHARASHTRA ◑ 2023 ◑ 60AA 346418

उपकोषागार कार्यालय, संगमनेर
पुरवठा दिनांक
05 SEP 2023
उपकोषागार अधिकारी, संगमनेर

११८१६

मुद्रांक विक्री बाबतची नोंद वही अनुक्रमांक दिनांक 13/9/2023

प्रतिज्ञापत्रासाठीचे कारण ----------

मुद्रांक विकत घेणाऱ्याचे नांव व रहिवासी पत्ता प्राचार्य एस.एम.बी.एस.टी. कॉलेज, संगमनेर

हस्ते असल्यास नाव व पत्ता ह: सकळकळे एम.एम.

मुद्रांक विकत घेणाऱ्याची सही

परवानाधारक मुद्रांक विक्रेत्याची सही ----------

व परवानाधारक तसेच मुद्रांक विक्रीचे ठिकाण/पत्ता- श्री.नितीन शिवाजी कुमठेकर
(मु.वि.प.क्र.१०४७१/९८)
१६३५,विश्वास झेरॉक्स,संगमनेर

Memorandum of Understanding (MOU)

Between

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&

Sahyadri Shikshan Mandal's,

Mahant Jamanadas Maharaj, Arts, Commerce and Science College, Karanjali Tal. Peth Nashik, 422208

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The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

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And

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IN WITNESS WHEREOF, the parties hereto have executed this MOU till 14th Sept. 2028

Dr.Ugalal P.Shinde **Principal** M.J.M. Arts, Commerce and Science Coll Karanjali, Nashik-422 206	Dr.Dinanath D.Patil Principal Sahakar Maharshi Bhausaheb Santuji Thorat College of Art's, Science & Commerce Sangamner - 422 605
Ms. Swapnali Wadje **Coordinator (H.O.D.Dept.of Mathematics)** **Sahyadri Shikshan Mandal's,** **Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208.** Mobile No:-+91-9860082601 Email:-	**Dr.Milind M.Sakalkale** **Coordinator (H.O.D.Dept.of Mathematics)** **S.B.V.P. Samaj's SahakarMaharshiBhausahebSantujiThorat College of Arts, Science & Commerce, Sangamner, Ahmednagar,Maharashtra-422605** Mobile No:-+91-9011035894 Email:- milindsakalkale68@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. Niranjan R. Giri	2) Dr. B. D. Wagh.
3) M. T. C. Gaikwad	4) (Prof:- V.R. Pande).

महाराष्ट्र MAHARASHTRA ◑ 2023 ◑ 60AA 346419

उपकोषागार कार्यालय, संगमनेर
पुरवठा दिनांक
05 SEP 2023
उपकोषागार अधिकारी, संगमनेर

मुद्रांक विक्री बाबतची नोंद वही अनुक्रमांक 99096 दिनांक 13/9/2023

प्रतिज्ञापत्रासाठीचे कारण ----------

मुद्रांक विकत घेणाऱ्याचे नांव व रहिवासी पत्ता प्राचार्य श्री.श्री.की.श्री.टी. ऑलेज, संगमनेर. हः सकळकडे

हस्ते असल्यास नाव व पत्ता ----------

मुद्रांक विकत घेणाऱ्याची सही श्री.श्री.

परवानाधारक मुद्रांक विक्रेत्याची सही ----------

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(मु.वि.प.प्रा.१०४७१/९८)
१६,३५,विश्वास प्लेऱॉक्स,संगमनेर

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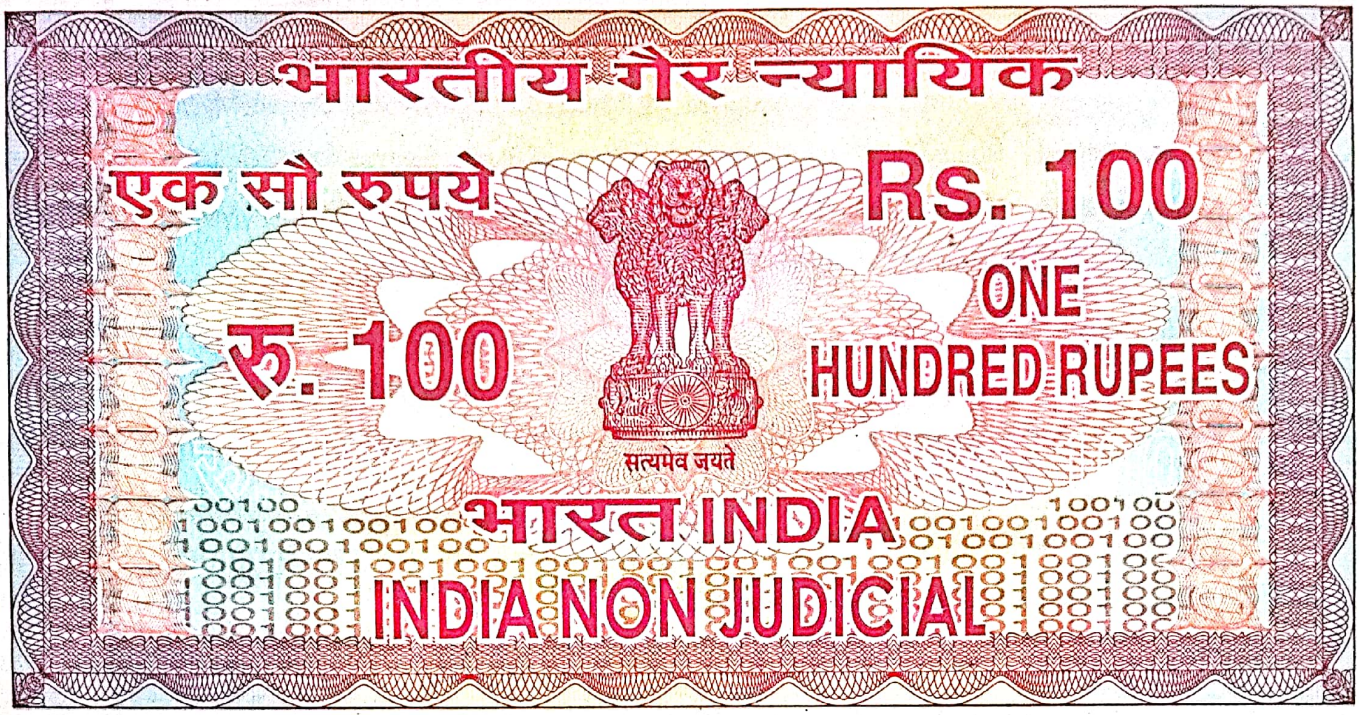
Dr.Ugalal P.Shinde **Principal** **M.J.M. Arts, Commerce and Science College** **Karanjali, Nashik 422 208**	Dr.Dinanath D.Patil **Principal** Sahakar Maharshi Bhausaheb Santuji Thorat College of Art's, Science & Commerce Sangamner - 422 605
Dr.Mahendra Shinde **Coordinator (H.O.D.Dept.of Physics)** **Sahyadri Shikshan Mandal's,** **Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208.** Mobile No:-+91-9423550299 Email:-	**Prof.Vijaykumar Pande** **Coordinator (H.O.D.Dept.of Physics)** **S.B.V.P. Samaj's SahakarMaharshiBhausahebSantujiThorat College of Arts, Science & Commerce, Sangamner, Ahmednagar,Maharashtra-422605** Mobile No:-+91-8329261029 Email:- vijaykumarpande111@gmail.com
Witnesses: Full Name, Signature, Date	
1) Mr. G.B.Dhomse	2) Dr. B.D. Wagh.
3) Dr. Girinivasan. A	4) Dr.M.M. Sakalkale



महाराष्ट्र MAHARASHTRA ◑ 2023 ◑ 60AA 448560

उपकोषागार कार्यालय, संगमनेर
पुरवठा दिनांक
03 OCT 2023
उपकोषागार अधिकारी, संगमनेर

मुद्रांक विक्री व नोंदवही अनुक्रमांक ११६०९
दि. 05 OCT 2023
प्रतिज्ञापत्र कोणाकडे सादर करावयाचे ----------
दस्ताचा प्रकार ----------
दस्त नोंदणी करणार आहात का ----------
मिळकतीचे वर्णन ----------
मुद्रांक विक्रेत्याचे नाव
पा०प्रा०स.म.भा.सं.यो.महाविद्या. संगमनेर ह.व्ही.एस.गुंजाळ निमज
सही Gunjal

दुस-या पक्षकाराचे नाव ----------
मुद्रांक शुल्क रक्कम ----------
परवानाधारक क्र. विक्रेत्याचे नाव/पत्ता
संगमनेर वकील संघ मर्या. संगमनेर
श्री. संजय बाबुराव भंडारी
(मु.वि.प.क्र.एस.टी.पी/एस.व्ही.एस.एस./५२६५/२००४)
सही ----------

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Dr.Niranjan Ramesh Giri Coordinator (H.O.D.Dept.of Zoology) Sahyadri Shikshan Mandal's, Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra -422208. Mobile No:-+91- Email:- niranjangiri.2013@gmail.com	Dr.Kamal Rangnath Dhakane 05/10/2023 Coordinator (H.O.D.Dept.of Zoology) S.B.V.P. Samaj's Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science & Commerce, Sangamner, Ahmednagar,Maharashtra-422605 Mobile No:-+91-8030822715 Email:- kamaldhakane@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. P.T. Wankhedkar 05/10/2023	2) Dr. B. D. Wagh. 05/10/2023
3) Dr. R.H. Waghchaure 05/10/2023	4) Kudnar. Asst.prof. kudnar S.S. 05/10/2023

महाराष्ट्र MAHARASHTRA ◐ 2020 ◐ YM 865499

अनुक्रमांक 2120 रुपये 100 दिनांक 24/11/2021

श्री. एम.जी.एम कॉलेज करंजाळी रा.

हस्ते श्री. प्रकाश पांडुरंग डुंबरे रा. तोंडले ता.पेठ

श्री. एन. पी. गवळी
स्टॅम्प वेंडर, तहसिल कचेरी पेठ,
परवाना क्र. १००/२००२

SUB TREASURY OFFICE
Peth, Dist. Nashik
22 NOV 2021
SUB TREASURY OFFICER
Peth

MEMORANDUM OF UNDERSTANDING

BETWEEN

Principal, Mahant Jamanadas Maharaj College of Arts Commerce And Science College,Karanjali,Tal-Peth,Dist-Nashik.

AND

[illegible]SHETE MARUTRAO GHULE [illegible]

Director, Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd.,

Date: 26/11/2021

This Memorandum of Understanding (MOU) is entered into as of date 26/11/2021 by and between the Principal, Mahant Jamanadas Maharaj College of Arts Commerce And Science College,Karanjali,Tal-Peth,Dist-Nashik and Director, Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd., Bhende (Bk.) Tal.-Newasa, Dist.- Ahmednagar

Preamble:

Mahant Jamanadas Maharaj Arts Commerce And Science College,Karanjali,

Mahant Jamanadas Maharaj College of Arts Commerce And Science run by the Sahyadri Shikshan Mandal Dindori was established in 2009 by Honorable Shri Narhari Sitaram Zirwal, a great social worker and diplomatic political leader in Peth and Dindori. College is the only imparting higher education in Science to tribal, rural and economically backward students in Peth Taluka. The college is newly established in 11 July 2009 in Peth Taluka, Dist. Nasik. That time there were no educational facilities in Science at the taluka level and for higher education one had to go to district place which was not at all feasible for common man.

College is affiliated to Savitribai Phule Pune University, Pune. At present the college is running only undergraduate discipline. The major objectives of this college is to provide education to the masses from all spere, urban, rural and tribal Keeping with the vision and mission of the Savitribai Phule Pune University and our Sahyadri Shikshan Mandal, we have been putting in all efforts to provide quality higher education to keep our students abreast with the new demands of the changing world.

Shri Dnyaneshwar Sahakari Sakhar Karkhana Ltd.

Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd., was established in 1973, in backward and project affected area of Jaikwadi Dam Irrigation Project of Ahmednagar District, under the able leadership of Late Marutrao Ghule Patil, the Founder Chairman of this Karkhana. The object of the sugar factory has not been remained to manufacture sugar from the sugarcane supplied by the farmers but now it has widened it's limitation, to achieve socio-economic development of the farmers as well as habitant of this area in the viscinity of the sugar factory. It has made progress in the educational field on the large scale. Educational institutions as well as technical institutes are established, With the help of this educational development of the rural area took place in the area of our factory.

The memorandum of understanding is being signed between **Mahant Jamanadas Maharaj College of Arts Commerce And Science, Karanjali** and **Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd, Bhende** for mutual exchange of research knowledge and for providing skill oriented persons to the industries.

Subject:

1. Biofertilizer Application, Soil and Water Analysis Program.
2. The industry will arrange to the extent possible, training of the faculty of the college if and when called upon to do so.
3. It will also arrange on-job training for the students in the manner to promote the knowledge and skill, which they can utilize for the performance of specific jobs.

4. The industry will assist in the evaluation of student's performance in theory, laboratory, workshop, field work and on the job training.
5. The industry will provide printed (including Xerox) and non-print materials available with them or that they can procure.
6. The industry and the college both together possibly will work on a specific research project concerned with above mentioned fields.
7. The college will provide skilled and knowledgeable persons to the industries or as per their requirements.
8. The two institutions will mutually decide upon the terms and conditions including financial support for the implementation of the above task.
9. We re-affirm our commitment to the courses and our willingness to make a consistent effort to ensure that they are implemented effectively and efficiently.
10. This MoU will be in force for ten years. After completion of ten years, it may extend after mutual concern of both the institutions.
11. **Mahant Jamanadas Maharaj College** and **Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd** welcome the establishment of this Memorandum for cooperation and jointly agree to the provisions as set out above. In this regard, **Dr. A.S.Jondhale,** Mahant Jamanadas Maharaj College and **Dr. B.D.Takate, Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd** will be a Coordinator to channelize the activities under the linkage.

LOKNETE MARUTRAO GHULE PA...

LOKNETE MARUTRAO GHULE P...

Dr. A.S. Jondhale

Co-ordinator

Dr. B.D.Takate

Co-ordinator

Signed on behalf of the institution seeking collaboration

Principal
M.J.M. Arts Commerce and Science College
Karanjali, Nashik-422 208

Signed on behalf of the institution providing support

Managing Director
Loknete Marutrao Ghule Pa...
Dnyaneshwar S.S.Karkhana L...
Dnyaneshwar Nagar, P.O. Bhende ...
Tal. Newase, Dist. A.Nagar-414...

M.J.M. COLLEGE KARANJALI TAL. PETH, DIST. NASHIK

भारतीय गैर न्यायिक

एक सौ रुपये

Rs. 100

रु. 100

ONE HUNDRED RUPEES

सत्यमेव जयते

भारत INDIA

INDIA NON JUDICIAL

महाराष्ट्र MAHARASHTRA ◐ 2020 ◐ YK 287654

अनुक्रमांक 9266 रुपये 100 दिनांक 24/08/21

श्री. महंत जमनादास महाराज कला वाणिज्य महाविद्यालय करंजाळी

हस्ते श्री. प्र. पो. देवरे नोंदणी

श्री. एच. पी. गवळी
स्टॅम्प वेंडर, तहसिल कचेरी पेठ,
परवाना क्र. १००/२००२

SUB TREASURY OFFICE
Peth, Dist. Nashik
24 AUG 2021
SUB TREASURY OFFICER

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (here in after referred as the "MoU" is made and executed on this 06th Day of September 2021 at Karanjali Maharashtra.

BETWEEN

Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, Tal. Peth, District. Nashik – 422208, Maharashtra State, India.

Through its Principal
(Here in referred as First Party)

AND

Sahyadri Bahujan Vidya Prasarak Samaj's, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science And Commerce, Sangamner, Tal – Sangamner, Dist.Ahmednagar – 422605. Maharashtra State, India.

Through its Principal

(Here in referred as Second Party)

The expressions "First Party" and "Second Party" Shall collectively be referred to as 'Parties' and individually as "Party"

WHEREAS:

A) First Party – Established in 2009 by Sahyadri Shikshan Mandal/s, Dindori, Tal – Peth, Dist.-Nashik, with the objective of providing higher education to the tribal youths from remote areas, affiliated to Savitribai Phule Pune University.

B) Second Party – Established in 1990 by Sahyadri Bahujan Vidya Prasarak Samaj, Sangamner, with objective of sculpturing youths by carving with higher education, is one of the best recognized college affiliated to Savitribai Phule Pune University, Pune.

C) The First Party and Second Party have expressed willingness to share knowledge and Human Resources (Teaching Staff) concerned with Botany Department of both the parties on the terms and conditions set out here in below;

IT IS AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Purpose/Objective of the MOU:

OBJECTIVES:

i) Explore and conserve Botanical world.

ii) The strive for greater, excellence in higher education to improve the efficiency of teaching as well as learning of both the parties.

iii) To exchange subject information and to share infrastructure facilities for the purpose of teaching subject of both the parties.

iv) As knowledge feast to organize guest lecturers for students of both the parties.

v) Guidance to the students regarding projects and seminars for empowerment of the students towards Excellence with scientific cultures and skills of both the parties.

vi) To develop Research skill among students and teaching staff of both the parties.

vii) Prof. A.S.Jondhale, Assistant Professor, and Department of Botany from Party 1: concerned with the completion of this MoU with respect to the above Objective.

2. Responsibilities of the Parties:

i) The First Party and Second Party will prepare a manual to guide the institute for accreditation.

ii) Both the parties agree that, in order to execute this MoU, there are existing agreements neither any third party will enter in to this MoU.

3. Term of Agreement:

The term of this MoU is for one year commencing from 6th Day of September 2021. The term can be extended up to two years after prior agreement of both and approval from University Grants Commission, New Delhi.

4. Confidentiality:

I. The Parties agree to maintain strict secrecy and confidentiality regarding any and all Confidential Information exchanged or to be exchanged between them in relation to this Agreement.

II. The parties agree to restrict access and disclosure of Confidential Information to such of their employees, agents, vendors and contractors strictly on a 'need to know' basis to maintain confidentiality of the Information disclosed to it in accordance with this clause.

a. Information and material disclosed and provide by each party to the other party in pursuance of or in connection with performance of its obligation under this agreement shall at all times remain the soul and exclusive property of the disclosing party.

2. Dispute Settlement:

Any dispute arising between the parties in connection with or arising out of the performance of mutual obligations under this MoU shall be resolved by mutual discussion and consultation. If the dispute remains even after 30 days, then dispute shall be referred to Dr. Mahindra Shinde, In charge Principal, Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, and Dr. Dinanath Patil, Principal, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science And Commerce, Sangamner. The decision of Principal and Manager of the Parties shall be final and binding on both parties.

IN WITNESS WHEREOF, the parties here to have put their hands and seals on the date, month and the year mentioned above.

For, Mahant Jamanadas Maharaj
Arts, Commerce and Science college,
Karanjali

Name Dr. Mahindra Shinde
Designation: Principal

INCHARGE PRINCIPAL
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

Witness:

1) Full Name: Dr. Deepak Tayde
Designation: Head of Chemistry

Head
Department of Chemistry
MJM Arts Commerce and Science College
Karanjali

2) Dr.Smita Chavan

M.J.M. COLLEGE
KARANJALI
TAL. PETH, DIST. NASHIK

For, Sahakar Maharshi Bhausaheb
Santuji Thorat College of Arts,
Science And Commerce, Sangamner.

Name, Dr. DinanathPatil
Designation: Principal

Principal
Sahakar Maharshi Bhausaheb Santuji Thorat
College of Art's, Science & Commerce
Sangamner - 422 605

Witness:

1) Full Name: Prof. Laxman Ghaywat
Designation: Coordinator, IQAC

IQAC Coordinator
S.M.B.S.T. College, Sangamner

2) Dr. B. D. Wagh

Head of the Botony Dept.
B.S.T. College, Sangamner
Dist. Ahmednagar Pin - 422 605

College
Code No. 201
Sangamner
TD No. PU/AN/
ASC/035/(1990)

भारतीय गैर न्यायिक

एक सौ रुपये

Rs. 100

रु. 100

ONE HUNDRED RUPEES

सत्यमेव जयते

भारत INDIA

INDIA NON JUDICIAL

महाराष्ट्र MAHARASHTRA ◐ 2020 ◐

YK 287652

अनुक्रमांक 9265 रुपये 100 दिनांक 24/8/21

श्री. महंत जमनादास महाराज कला वाणिज्य महाविद्यालय करंजाळी

हस्ते श्री प्र. प्रो. डॉ. पाटील

श्री. एच. पी. गवळी
स्टॅम्प वेंडर, तहसिल कचेरी पेठ,
परवाना क्र. १००/२००२

SUB TREASURY OFFICE
Peth Dist. Nashik
24 AUG 2021
SUB TREASURY OFFICER

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (here in after referred as the "MoU" is made and executed on this 06th Day of September 2021 at Karanjali Maharashtra.

BETWEEN

Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, Tal. Peth, District. Nashik – 422208, Maharashtra State, India.

Through its Principal
(Here in referred as First Party)

AND

SahyadriBahujanVidyaPrasarakSamaj's, SahakarMaharshiBhausahebSantujiThorat College of Arts, Science And Commerce, Sangamner, Tal – Sangamner, Dist.Ahmednagar – 422605. Maharashtra State, India.

Through its Principal

(Here in referred as Second Party)

The expressions "First Party" and "Second Party" Shall collectively be referred to as 'Parties' and individually as "Party"

WHEREAS:

A) First Party – Established in 2009 by Sahyadri Shikshan Mandal/s, Dindori, Tal – Peth, Dist.-Nashik, with the objective of providing higher education to the tribal youths from remote areas, affiliated to Savitribai Phule Pune University.

B) Second Party – Established in 1990 by SahyadriBahujanVidyaPrasarakSamaj, Sangamner, with objective of sculpturing youths by carving with higher education, is one of the best recognized college affiliated to Savitribai Phule Pune University, Pune.

C) The First Party and Second Party have expressed willingness to share knowledge and Human Resources (Teaching Staff) concerned with ChemistryDepartment of both the parties on the terms and conditions set out here in below:

IT IS AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Purpose/Objective of the MOU:

OBJECTIVES:

i) To shareknowledgeofChemicalworld.

ii) The strive for greater, excellence in higher education to improve the efficiency of teaching as well as learning of both the parties.

iii) To exchange subject information and to share Lab and infrastructure facilities for the purpose of teaching subject of both the parties.

iv) As knowledge feast to organize guest lectures for students of both the parties.

v) Guidance to the students regarding projects and seminars for empowerment of the students towards Excellence with scientific cultures and skills of both the parties.

vi) To develop Research skill among students and teaching staff of both the parties.

vii) Dr. D.T.Tayde, Assistant Professor, and Department of Chemistry from Party 1: concerned with the completion of this MoU with respect to the above Objective.

2. Responsibilities of the Parties:

i) The First Party and Second Party will prepare a manual to guide the institute for accreditation.

ii) Both the parties agree that, in order to execute this MoU, there are existing agreements neither any third party will enter in to this MoU.

3. Term of Agreement:

The term of this MoU is for one year commencing from 06th Day of September 2021. The term can be extended up to two years after prior agreement of both and approval from University Grants Commission, New Delhi.

4. Confidentiality:

I. The Parties agree to maintain strict secrecy and confidentiality regarding any and all Confidential Information exchanged or to be exchanged between them in relation to this Agreement.

II. The parties agree to restrict access and disclosure of Confidential Information to such of their employees, agents, vendors and contractors strictly on a 'need to know' basis to maintain confidentiality of the Information disclosed to it in accordance with this clause.

a. Information and material disclosed and provide by each party to the other party in pursuance of or in connection with performance of its obligation under this agreementshall at all times remain the soul and exclusive property of the disclosing party.

2. Dispute Settlement:

Any dispute arising between the parties in connection with or arising out of the performance of mutual obligations under this MoU shall be resolved by mutual discussion and consultation. If the dispute remains even after 30 days, then dispute shall be referred to Dr. Mahindra Shinde, In charge Principal, Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, and Dr. DinanathPatil, Principal,SahakarMaharshiBhausaheabSantujiThoratCollege of Arts, Science And Commerce, Sangamner. The decision of Principal and Manager of the Parties shall be final and binding on both parties.

IN WITNESS WHEREOF, the parties here to have put their hands and seals on the date, month and the year mentioned above.

For, Mahant Jamanadas Maharaj
Arts, Commerce and Science college,
Karanjali Science And Commerce, Sangamner.

Name Dr. Mahindra Shinde
Designation: Incharge Principal

INCHARGE PRINCIPAL
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

For, Sahakar Maharshi Bhausaheb
Santuji Thorat College of Arts,

Name, Dr. Dinanath Patil
Designation: Principal

Principal
Sahakar Maharshi Bhausaheb Santuji Thorat
College of Art's, Science & Commerce
Sangamner - 422 605

Witness:
1) Full Name: Mr. Ravindra H. Waghchure
(Assistant Prof. of Dept. of Chemistry)

2) Mr.Rohit M. Nikam
(Assistant Prof. of Dept. of Chemistry)

Witness:
1) Full Name: Prof. Laxman Ghaywat
Designation: Coordinator, IQAC

IQAC Coordinator
M.B.S.T. College, Sangamner

2) Dr. S. S. Borade
(Head of Dept. of Chemistry)

Dr. S. S. Borhade
HOD, Dept. of Chemistry
M.B.S.T. College, Sangamner

M.J.M. COLLEGE ★ KARANJALI ★ TAL. PETH, DIST. NASHIK

Sahakar Maharshi Bhausaheb Santuji Thorat College of Art's, Science & Commerce Sangamner
College Code No. 201
Sangamner
ID No. PU/AN/
ASC/035/(1990)

भारतीय गैर न्यायिक

एक सौ रुपये Rs. 100

रु. 100 ONE HUNDRED RUPEES

सत्यमेव जयते

भारत INDIA

INDIA NON JUDICIAL

महाराष्ट्र MAHARASHTRA ◐ 2020 ◐ YM 864244

अ. क्र. ३५४० रुपये १०० दि. ०४/१०/२०२१

नी/सौ. कामा. जे. म. म. कॉलेज करंजाळी

ता.: ता. पेठ, जि. नाशिक

स्ते : सकाराम पांडुरंग भोये

बी. बी. भोंड. कोठारी ११५/२००३
स्टॅम्प वेंडर, तहसिल कार्यालय, पेठ

SUB TREASURY OFFICE
Peth, Dist. Nashik
04 OCT 2021
SUB TREASURY OFFICER
Peth

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (here in after referred as the "MoU" is made and executed on this 08th Day of October 2021 at Karanjali Maharashtra.

BETWEEN

Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, Tal. Peth, District. Nashik – 422208, Maharashtra State, India.

Through its Principal
(Here in referred as First Party)

AND

Sahyadri Bahujan Vidya Prasarak Samaj's, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science And Commerce, Sangamner, Tal – Sangamner, Dist.Ahmednagar – 422605, Maharashtra State, India.

Through its Principal

(Here in referred as Second Party)

The expressions "First Party" and "Second Party" Shall collectively be referred to as 'Parties' and individually as "Party"

WHEREAS:

A) First Party – Established in 2009 by Sahyadri Shikshan Mandal/s, Dindori, Tal – Peth, Dist.-Nashik, with the objective of providing higher education to the tribal youths from remote areas, affiliated to Savitribai Phule Pune University.

B) Second Party – Established in 1990 by Sahyadri Bahujan Vidya Prasarak Samaj, Sangamner, with objective of sculpturing youths by carving with higher education, is one of the best recognized college affiliated to Savitribai Phule Pune University, Pune.

C) The First Party and Second Party have expressed willingness to share knowledge and Human Resources (Teaching Staff) concerned with Mathematics Department of both the parties on the terms and conditions set out here in below;

IT IS AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Purpose/Objective of the MOU:

OBJECTIVES:

i) The strive for greater, excellence in higher education to improve the efficiency of teaching as well as learning of both the parties.

ii) To exchange subject information and to share infrastructure facilities for the purpose of teaching subject of both the parties.

iii) As knowledge feast to organize guest lecturers for students of both the parties.

iv) Guidance to the students regarding projects and seminars for empowerment of the students towards Excellence with scientific cultures and skills of both the parties.

v) To develop Research skill among students and teaching staff of both the parties.

vi) Mr. M.M.Kamale, Assistant Professor, and Department of Mathematics from Party 1: concerned with the completion of this MoU with respect to the above Objective.

2. Responsibilities of the Parties:

i) The First Party and Second Party will prepare a manual to guide the institute for accreditation.

ii) Both the parties agree that, in order to execute this MoU, there are existing agreements neither any third party will enter in to this MoU.

3. Term of Agreement:

The term of this MoU is for one year commencing from 8th Day of October 2021. The term can be extended up to two years after prior agreement of both and approval from University Grants Commission, New Delhi.

4. Confidentiality:

I. The Parties agree to maintain strict secrecy and confidentiality regarding any and all Confidential Information exchanged or to be exchanged between them in relation to this Agreement.

II. The parties agree to restrict access and disclosure of Confidential Information to such of their employees, agents, vendors and contractors strictly on a 'need to know' basis to maintain confidentiality of the Information disclosed to it in accordance with this clause.

a. Information and material disclosed and provide by each party to the other party in pursuance of or in connection with performance of its obligation under this agreement shall at all times remain the soul and exclusive property of the disclosing party.

2. Dispute Settlement:

Any dispute arising between the parties in connection with or arising out of the performance of mutual obligations under this MoU shall be resolved by mutual discussion and consultation. If the dispute remains even after 30 days, then dispute shall be referred to Dr. Mahindra Shinde, In charge Principal, Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, and Dr. Dinanath Patil, Principal, Sahakar Maharshi Bhausaheab Santuji Thorat College of Arts, Science And Commerce, Sangamner. The decision of Principal and Manager of the Parties shall be final and binding on both parties.

IN WITNESS WHEREOF, the parties here to have put their hands and seals on the date, month and the year mentioned above.

For, Mahant Jamanadas Maharaj
Arts, Commerce and Science college,
Karanjali

Name Dr. Mahindra Shinde
Designation: Principal

INCHARGE PRINCIPAL
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

Witness:

1) Full Name: Dr. Deepak Tayde
Designation: Head of Chemistry

2) Dr.R.M.Nikam

M.J.M. COLLEGE
KARANJALI
TAL. PETH, DIST. NASHIK

For, Sahakar Maharshi Bhausaheb
Santuji Thorat College of Arts,
Science And Commerce, Sangamner.

Name, Dr. Dinanath Patil
Designation: Principal

Principal
Sahakar Maharshi Bhausaheb Santuji Thorat
College of Art's, Science & Commerce
Sangamner - 422 605

Witness:

1) Full Name: Prof. Laxman Ghaywat
Designation: Coordinator, IQAC

IQAC Coordinator
S.M.B.S.T. College, Sangamner

2) Dr. Milind M. Sakalkale
Head
Department of Mathematics
S.M.B.S.T. College, Sangamner

College
Code No. 201
Sangamner
ID No. PU/AN/
ASC/035/(1988)

भारतीय गैर न्यायिक

एक सौ रुपये

Rs. 100

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भारत INDIA

INDIA NON JUDICIAL

महाराष्ट्र MAHARASHTRA ◐ 2020 ◐ YK 287653

अनुक्रमांक ९२६ रुपये १०० दिनांक २१/९/२१

श्री. महंत जमनादास महाराज कला वाणिज्य महाविद्यालय करंजाळी

हस्ते श्री. प्र. प्रा. ईथर

श्री. एच. पी. गवळी
स्टॅम्प वेंडर, तहसिल कचेरी पेठ,
परवाना क्र. १००/२००२

SUB TREASURY OFFICE
Dist. Nashik
24 SEP 2021
SUB TREASURY OFFICER

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (here in after referred as the "MoU" is made and executed on this 06th Day of September 2021 at Karanjali Maharashtra.

BETWEEN

Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, Tal. Peth, District. Nashik – 422208, Maharashtra State, India.

Through its Principal
(Here in referred as First Party)
AND

AND

Sahyadri Bahujan Vidya Prasarak Samaj's, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science And Commerce, Sangamner, Tal – Sangamner, Dist.Ahmednagar – 422605. Maharashtra State, India.

Through its Principal

(Here in referred as Second Party)

The expressions "First Party" and "Second Party" Shall collectively be referred to as 'Parties' and individually as "Party"

WHEREAS:

A) First Party – Established in 2009 by Sahyadri Shikshan Mandal/s, Dindori, Tal – Peth, Dist.-Nashik, with the objective of providing higher education to the tribal youths from remote areas, affiliated to Savitribai Phule Pune University.

B) Second Party – Established in 1990 by Sahyadri Bahujan Vidya Prasarak Samaj, Sangamner, with objective of sculpturing youths by carving with higher education, is one of the best recognized college affiliated to Savitribai Phule Pune University, Pune.

C) The First Party and Second Party have expressed willingness to share knowledge and Human Resources (Teaching Staff) concerned with Physics Department of both the parties on the terms and conditions set out here in below;

IT IS AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Purpose/Objective of the MOU:

OBJECTIVES:

i) Explore and make available the Physics concern Laboratory and and Instrumentation facility.

ii) The strive for greater, excellence in higher education to improve the efficiency of teaching as well as learning of both the parties.

iii) To exchange subject information and to share infrastructure facilities for the purpose of teaching subject of both the parties.

iv) As knowledge feast to organize guest lecturers for students of both the parties.

v) Guidance to the students regarding projects and seminars for empowerment of the students towards Excellence with scientific cultures and skills of both the parties.

vi) To develop Research skill among students and teaching staff of both the parties.

vii) Dr. M.S.Shinde, Assistant Professor, and Department of Physics from Party 1: concerned with the completion of this MoU with respect to the above Objective.

2. Responsibilities of the Parties:

i) The First Party and Second Party will prepare a manual to guide the institute for accreditation.

ii) Both the parties agree that, in order to execute this MoU, there are existing agreements neither any third party will enter in to this MoU.

3. Term of Agreement:

The term of this MoU is for one year commencing from 6th Day of September 2021. The term can be extended up to two years after prior agreement of both and approval from University Grants Commission, New Delhi.

4. Confidentiality:

I. The Parties agree to maintain strict secrecy and confidentiality regarding any and all Confidential Information exchanged or to be exchanged between them in relation to this Agreement.

II. The parties agree to restrict access and disclosure of Confidential Information to such of their employees, agents, vendors and contractors strictly on a 'need to know' basis to maintain confidentiality of the Information disclosed to it in accordance with this clause.

a. Information and material disclosed and provide by each party to the other party in pursuance of or in connection with performance of its obligation under this agreement shall at all times remain the soul and exclusive property of the disclosing party.

2. Dispute Settlement:

Any dispute arising between the parties in connection with or arising out of the performance of mutual obligations under this MoU shall be resolved by mutual discussion and consultation. If the dispute remains even after 30 days, then dispute shall be referred to Dr. Mahendra Shinde, In charge Principal, Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, and Dr. Dinanath Patil, Principal, Sahakar Maharshi Bhausaheab Santuji Thorat College of Arts, Science And Commerce, Sangamner. The decision of Principal and Manager of the Parties shall be final and binding on both parties.

IN WITNESS WHEREOF, the parties here to have put their hands and seals on the date, month and the year mentioned above.

For, Mahant Jamanadas Maharaj
Arts, Commerce and Science college,
Karanjali

Name Dr. Mahendra Shinde
Designation: Principal

INCHARGE PRINCIPAL
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

Witness:

1) Full Name: Prof. T.C. Gaikwad
Designation: Assi. Professor in Chemistry

2) Prof. R.H.Waghchaure

M.J.M. COLLEGE
KARANJALI
TAL. PETH, DIST. NASHIK

For, Sahakar Maharshi Bhausaheb
Santuji Thorat College of Arts,
Science And Commerce, Sangamner.

Name, Dr. DinanathPatil
Designation: Principal

Principal
Sahakar Maharshi Bhausaheb Santuji Thorat
College of Art's. Science & Commerce
Sangamner - 422 605

Witness:

1) Full Name: Prof. Laxman Ghaywat
Designation: Coordinator, IQAC

IQAC Coordinator
S.M.B.S.T. College, Sangamner

2) Mr. Vijay Kumar Pande

HEAD
Department of Physics
SMBS Thorat College
Sangamner

College Code No. 291
Sangamner
ID No. PU/AN/
ASC/035/(1990)

भारतीय गैर न्यायिक

एक सौ रुपये Rs. 100

रु. 100 ONE HUNDRED RUPEES

सत्यमेव जयते

भारत INDIA

INDIA NON JUDICIAL

महाराष्ट्र MAHARASHTRA ◐ 2020 ◐ YM 864245

अ. क्र. ... दि. ...

श्री/सौ. ...

रा. ...

हस्ते : ...

श्री. पी. श्रेड. कोठारी ११५/२००३
स्टॅम्प वेंडर, तहसिल कार्यालय, पेठ

SUB TREASURY OFFICE
Peth, Dist. Nashik
04 OCT 2021
SUB TREASURY OFFICER
Peth

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (here in after referred as the "MoU" is made and executed on this 08th Day of October 2021 at Karanjali Maharashtra.

BETWEEN

Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, Tal. Peth, District. Nashik – 422208, Maharashtra State, India.

Through its Principal
(Here in referred as First Party)

AND

Sahyadri Bahujan Vidya Prasarak Samaj's, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science And Commerce, Sangamner, Tal – Sangamner, Dist.Ahmednagar – 422605. Maharashtra State, India.

Through its Principal

(Here in referred as Second Party)

The expressions "First Party" and "Second Party" Shall collectively be referred to as 'Parties' and individually as "Party"

WHEREAS:

A) First Party – Established in 2009 by Sahyadri Shikshan Mandal/s, Dindori, Tal – Peth, Dist.-Nashik, with the objective of providing higher education to the tribal youths from remote areas, affiliated to Savitribai Phule Pune University.

B) Second Party – Established in 1990 by Sahyadri Bahujan Vidya Prasarak Samaj, Sangamner, with objective of sculpturing youths by carving with higher education, is one of the best recognized college affiliated to Savitribai Phule Pune University, Pune.

C) The First Party and Second Party have expressed willingness to share knowledge and Human Resources (Teaching Staff) concerned with Zoology Department of both the parties on the terms and conditions set out here in below;

IT IS AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Purpose/Objective of the MOU:

OBJECTIVES:

i) The strive for greater, excellence in higher education to improve the efficiency of teaching as well as learning of both the parties.

ii) To exchange subject information and to share infrastructure facilities for the purpose of teaching subject of both the parties.

iii) As knowledge feast to organize guest lecturers for students of both the parties.

iv) Guidance to the students regarding projects and seminars for empowerment of the students towards Excellence with scientific cultures and skills of both the parties.

v) To develop Research skill among students and teaching staff of both the parties.

vi) Prof. N.R.Giri, Assistant Professor, and Department of Zoology from Party 1: concerned with the completion of this MoU with respect to the above Objective.

2. Responsibilities of the Parties:

i) The First Party and Second Party will prepare a manual to guide the institute for accreditation.

ii) Both the parties agree that, in order to execute this MoU, there are existing agreements neither any third party will enter in to this MoU.

3. **Term of Agreement:**
The term of this MoU is for one year commencing from 8th Day of October 2021. The term can be extended up to two years after prior agreement of both and approval from University Grants Commission, New Delhi.

4. **Confidentiality:**

I. The Parties agree to maintain strict secrecy and confidentiality regarding any and all Confidential Information exchanged or to be exchanged between them in relation to this Agreement.

II. The parties agree to restrict access and disclosure of Confidential Information to such of their employees, agents, vendors and contractors strictly on a 'need to know' basis to maintain confidentiality of the Information disclosed to it in accordance with this clause.

a. Information and material disclosed and provide by each party to the other party in pursuance of or in connection with performance of its obligation under this agreement shall at all times remain the soul and exclusive property of the disclosing party.

2. **Dispute Settlement:**

Any dispute arising between the parties in connection with or arising out of the performance of mutual obligations under this MoU shall be resolved by mutual discussion and consultation. If the dispute remains even after 30 days, then dispute shall be referred to Dr. Mahindra Shinde, In charge Principal, Mahant Jamanadas Maharaj Art's, Commerce and Science College, Karanjali, and Dr. Dinanath Patil, Principal, Sahakar Maharshi Bhausaheab Santuji Thorat College of Arts, Science And Commerce, Sangamner. The decision of Principal and Manager of the Parties shall be final and binding on both parties.

IN WITNESS WHEREOF, the parties here to have put their hands and seals on the date, month and the year mentioned above.

For, Mahant Jamanadas Maharaj
Arts, Commerce and Science college,
Karanjali

Name Dr. Mahindra Shinde
Designation: Principal

INCHARGE PRINCIPAL
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

Witness:
1) Full Name: Dr. Deepak Tayde
Designation: Head of Chemistry

2) Dr.P.T.Wankhedkar

M.J.M. COLLEGE KARANJALI TAL. PETH, DIST. NASHIK

For, Sahakar Maharshi Bhausaheb
Santuji Thorat College of Arts,
Science And Commerce, Sangamner.

Name, Dr. Dinanath Patil
Designation: Principal

Principal
Sahakar Maharshi Bhausaheb Santuji Thorat
College of Art's, Science & Commerce
Sangamner - 422 605

Witness:
1) Full Name: Prof. Laxman Ghaywat
Designation: Coordinator, IQAC

IQAC Coordinator
S.M.B.S.T. College, Sangamner

2) Dr. G.J.Thorat
Head of the Zoology Dept.
S. S. T College, Sangamner
Dist - Ahmednagar - 422608

College Code No. 201 Sangamner ID No. PU/AN/ ASC/035/(1990)

महाराष्ट्र MAHARASHTRA ◐ 2020 ◐ YM 865498

अनुक्रमांक २०४० रुपये १०० दिनांक २३/११/२०२१

श्री. एम जी एम कॉलेज करंजाळी

हस्ते श्री. प्रकाश पांडुरंग डेपाळे रा तोंडल ता पेठ

श्री. एच. पी. गवळी
स्टॅम्प वेंडर, तहसिल कचेरी पेठ,
परवाना क्र. १००/२००२

SUB TREASURY OFFICE
Peth, Dist. Nashik
22 NOV 2021
SUB TREASURY OFFICER
Peth

MEMORANDUM OF UNDERSTANDING

BETWEEN

Principal, Mahant Jamanadas Maharaj College of Arts Commerce And Science College,Karanjali,Tal-Peth,Dist-Nashik.

And

Principal, Jijamata College of Science and Arts, Bhende (Bk.) Tal.-Newasa, Dist.- Ahmednagar

Date: 26/11/2021

This Memorandum of Understanding (MOU) is entered into as of date 26/11/2021 by and between the Principal, Mahant Jamanadas Maharaj College of Arts Commerce And Science College,Karanjali,Tal-Peth,Dist-Nashik and Principal, Jijamata College of Science and Arts, Bhende (Bk.) Tal.-Newasa, Dist.- Ahmednagar

WHEREAS, Mahant Jamanadas Maharaj College of Arts Commerce And Science College, Karanjali and Jijamata College of Science and Arts, Bhende have many areas of common interest in Arts, Commerce and Sciences, considerable advantage may be gained from their pursuit on a collaborative basis in the fields of academics, education and research. NOW THEREFORE, **Mahant Jamanadas Maharaj College** and **Jijamata College** have decided to enter into this Memorandum of Understanding (here in after referred to as MoU), which defines the framework for the cooperation of the two institutions set out in the following:

ARTICLE 1: OBJECT Both Institutes agree to develop the following collaborative activities in the academic areas of mutual interest, on a basis of equality and reciprocity.

The two institutions shall seek to promote:

a. Faculty/Staff Exchanges

1) The exchange of faculty to the mutual benefit of both institutions,
2) Collaboration in teaching, research and development, and consultancy studies in the field of mutual interest,
3) The exchange of academic materials and publications,
4) Conducting lectures,
5) Undertaking joint research,
6) Attachment of staff for purposes of curriculum development and review, attendance of courses, upgrading of teaching and research skills,
7) Participating in seminars, symposiums, and other types of academic discussions,
8) Co-supervising post-graduate students,
9) Conducting study tours and joint consultancy work.

b. Student Exchanges

A home institution refers to the institution where a student is a full-time student, and from where he/she is expected to graduate. A host institution refers to an institution that receives a student for a brief period of time to undertake a pre-determined programme of study or research.

1) Exchange students will be selected by mutual agreement between the home institution and the host institution.
2) His/her programme of study at the host institution will be determined by mutual consultation between his/her academic advisor at the home institution and his/her "interim" academic advisor identified by the host institution.
3) The host institution will evaluate an exchange student's performance in each course.

4) If an exchange student has undertaken research, then the host institution will evaluate the exchange student's performance in the research.
5) **Mahant Jamanadas Maharaj College** and **Jijamata College** agree to provide suitable accommodation for student exchange.
6) The exchange students will pay tuition and other fees at their home institution.

c. Other Areas:

1) To exchange information on research and educational programs,
2) To exchange information on teaching, learning material and other literature relevant to their educational and research programs,
3) To jointly organize short-term continuing education programs on topics of mutual interest and to invite each other's faculty to participate therein,
4) To organize jointly seminars, conferences, or workshops on topics of mutual interest and to invite each other's faculty to participate therein,
5) To propose and engage jointly in research or training programs sponsored by funding agencies, and to invite each other's faculty to participate therein,
6) To exchange, on a reciprocal basis, students at UG, PG and Doctoral levels for limited periods of time for purpose of education and /or research,
7) The provision of cultural and intellectual enrichment opportunities for staff and students of both institutes,
8) To use laboratory facilities in specific cases for a limited period,
9) To permit students, staff and faculty members to use library facility.

VALIDITY

The Memorandum shall remain in force for a period of **TEN (10) years** commencing from effective date. Institutions may extend the term by written agreement signed by both after review.

TERMINATION

: Either institution may terminate the MoU by giving written notice of six months in advance to the other institution. Once terminated, both **Mahant Jamanadas Maharaj College** and **Jijamata College** will be responsible for any losses, financial or otherwise, which the other institutions may suffer. However, **Mahant Jamanadas Maharaj College** and **Jijamata College** will ensure that the provisions of this Memorandum shall continue to apply to all activities in progress until their completion

Mahant Jamanadas Maharaj College and **Jijamata College** welcome the establishment of this Memorandum for cooperation and jointly agree to the provisions as set out above. In this regard, **Dr. Avinash Jondhale,** Mahant Jamanadas Maharaj College and **Dr. Madhukar Navgire,** Jijamata College will be a Coordinator to channelize the activities under the linkage.

Dr. Avinash Jondhale
Co-ordinator

Dr. Madhukar Navgire
Co-ordinator

Dr. M.S.Shinde
Principal
M. J. M. Arts Commerce And Science College,Karanjali

Principal
M.J.M. Art: Commerce
and Science College
Karanjali, Nashik-422 208

Dr. R . R. Saswade
Principal
Jijamata College of Science and Arts,Bhende (Bk.)

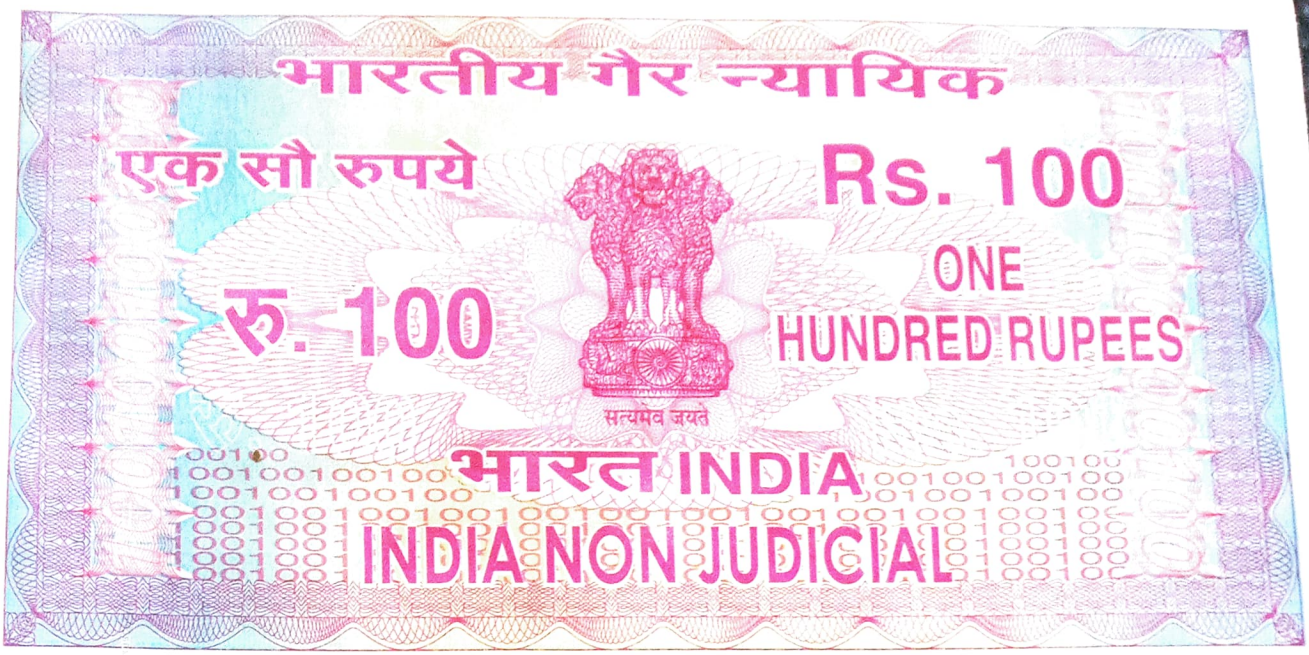
INCHARGE PRINCIPAL
Jijamata College of Science & Arts
Dnyaneshwarnagar, Tal. Newasa
Dist. Ahmednagar

Official Stamp

M.J.M. COLLEGE KARANJALI TAL. PETH, DIST. NASHIK

Official Stamp

Jijamata College of Science & Arts ID/NO. PU/AN/S/ 043/1992 Bhende-414605



महाराष्ट्र MAHARASHTRA ◐ 2020 ◐ YM 865500

अनुक्रमांक --2080-- रुपये --100-- दिनांक 25/11/2021

श्री. एम जी एम कॉलेज करंजाळी रा. ----------

हस्ते श्री. प्रकाश पांडुरंग रेपाळ रा. तोंडवळ ता.पे

श्री. एच.पी. नाईकळी
स्टॅम्प वेंडर, तहसिल कचेरी पेठ,
परवाना क्र. १००/२००२

SUB TREASURY OFFICE
Petn. Dist. Nashik
22 NOV 2021

Without Prejudice,

Memorandum of Understanding (MOU)

Between

Gokhale Education Society's

HPT Arts and RYK Science College, Nashik, Maharashtra- 422005

&

Sahyadri Shikshan Mandal's,

Mahant Jamanadas Maharaj, Arts Commerce and Science College, Karanjali

This document constitutes as Memorandum of Understanding(MOU) between HPT Arts and RYK Science College, Nashik, Maharashtra- 422005 and Mahant Jamanadas Maharaj, Arts Commerce and Science College, Karanjali, Maharashtra-422208 on13th April2022

1.Aim of this MOU:

Knowledge exchange for students and staff training through workshops, seminars, and guest lectures.Vide this MOU both the parties agree for the same with mutual consent.

2.Objective:

The objective of this MOU is to express the willingness of both parties to engage in an effort to promote collaborative activities in the following areas:

Internship

Industrial visits

Knowledge sharing

Joint research and publications

Resources sharing and exchange

3)This MOU shall be effective only after HPT Arts and RYK Science College, Nashik and Mahant Jamanadas Maharaj, Arts Commerce and Science College, Karanjali, mutually agreed the terms & conditions.

4. General Terms Of MOU:

4a)Duration of MOU: This MOU shall be operational upon signing and will have initial duration of 5(Five) years i.e. on or before 31st March2027. All Activities conducted before this date within the vision/objects of this joint collaboration will be deemed to fall under this MOU.

4b)Coordination: In order to carry out and fulfil the aims of this MOU, each party to appoint an appropriate person(s) to represent its organization and to coordinate, implementation of activities. Full names, designations, Mobile nos, Email IDs of such persons will be incorporated in this MOU.

4c)Financial Implementations: There is no financial cost, liability in any manner whatsoeveris involved in this MOU fromboth the parties. No right/title/interest in any manner will be created in the either of college properties and, or, otherwise by anybody.There will be no cost, charge by HPT Arts and RYK Science College, Nashik- 422005 as the aforesaid objective is being carried out in the form of voluntary activity for the sake of student's and teacher's benefit at large.

4d)Confidentiality: Each party agrees that it shall not, at any time, after executing the activities of this MOU, will disclose any information without mutual consent.

4e)Termination of MOU: This MOU shall terminate any time with 1(One) month prior written notice to each other by both the parties without assigning any reason.

4f) Extension of MOU: This MOU will be further extendible by 1(One) year, at the mutual consent of both parties on further mutually agreed terms.

4g)Communications: All communications by both the parties shall be done by Email, ordinary post. Only in case of termination of MOU communication will be done by Email followed by Registered Post A/D to the other party.

4h)Addendum: Any addendum to this MOU shall be in writing & signed by both the parties.

Herewith both the parties confirm that provisions in this MOU does not go against the rules and regulations of the Government policies.

Aforesaid all terms & conditions also apply to any subsequent Addendum to this MOU.

IN WITNESS WHEREOF, the parties hereto have executed this MOU on 31st March 2027

Dr.V.N.Suryavanshi Principal PRINCIPAL H.P.T. Arts / R.Y.K. Sc. College Nasik-5	Dr.M.S.Shinde Principal
For HPT Arts and RYK Science College, Nashik, Maharashtra- 422005	**Mahant Jamanadas Maharaj, Arts Commerce And Science College, Karanjali, Maharashtra-422208.**
H.P.T. Arts & R.Y.K. Science College NASHIK 05.	M. J. M. COLLEGE KARANJALI TAL. PETH, DIST. NASHIK
Coordinator Prof. (Dr.) Sanjay G. Auti **HPT Arts and RYK Science College, Nashik, Maharashtra- 422005** Mobile NO.- +91-9423080468 Email. hptbot@gmail.com	**Coordinator** Dr.Avinash S. Jondhale **Mahant Jamanadas Maharaj, Arts Commerce and Science College, Karanjali, Maharashtra -422208.** Mobile No:-+91-9422144082 Email:-avinashjondhale51@gmail.com
Witnesses: Full Name, Signature, Date	
1) Dr. Mrs. Udaya G. Basarkar	2) Dr. Chavan. Smita. P.
3) Dr. K.V.C. Gosavi.	4) Dr. D.T. Tayde

MARATHA VIDYA PRASARAK SAMAJ'S
Karmveer Abasaheb Alias N. M. Sonawane
ARTS, COMMERCE AND SCIENCE COLLEGE, SATANA
Tal. Baglan, Dist. Nashik (MS) INDIA. Pin - 423 301
NAAC Re-Accredited "A" Grade
BEST RURAL COLLEGE AWARD OF SAVITRIBAI PHULE PUNE UNIVERSITY

Dr. Vijay J. Medhane
M.Sc., Ph.D.
Principal

Affiliated to Savitribai Phule Pune University
Id No. PU/NS/ACS/008 (1967)

College Code No.: 026
Center Code No.: 052

Junior College Index No.
13.12.002

ASC/Stn/2020-21/142

Date:- 01.01.2020

Collaboration/Linkage Certificate/Memorandum of Understanding (MOU)

To whomsoever it may be concern

This is to certify that **Department of Chemistry of Karmaveer Abasaheb Alias N.M. Sonawane Arts, Commerce and Science College, Satana, District-Nashik - 423301, Affiliated to SPPU, Pune, Maharashtra,** has research collaboration ,since 2020 with **Department of Chemistry, Mahant Jamnadas Maharaj Arts, Commerce and Science College, Karanjali, Taluka- Peth, District-Nashik. Affiliated to Savitribai Phule Pune University, Pune** for sharing the research ideas, exchange of reprints of our research papers and for the sample characterizations, publication of research papers. We have jointly worked on research topics related to the application of nanoparticles, synthesis of organic compounds and their applications and have published the research papers in reputed international journals.

We have further extended this linkage with both the Chemistry departments to review the curriculum, teaching practices, research based on nanotechnology, instrumentation techniques and discuss ways in which courses could be revised to promote scientific knowledge among the students and faculty members.

• Principal e-mail id : vjmedhane1664@gmail.com, vj_medhane@rediffmail.com • Mobile No. : 9423968434
• College Phone No. : (02555) 223042 Fax : (02555) 223042 • e-mail id : nmsasc@yahoo.co.in • website : www.kaanmssatanacollege.edu.in
Central Office : Maratha Vidya Prasarak Samaj, Nashik, Shivaji Nagar, Gangapur Road, Nashik - 422 002.
• Phone No. : (0253) 2574511, 2573422 • Fax No. : (0253) 2579863 • e-mail id : ndmvpsamajnashik@yahoo.co.in • website : www.mvp.edu.in

Objectives of MOU/Collaboration/Linkage

1. To promote academic and professional interest between both the institutes Department of Chemistry, K.A.A.N.M.S Arts, Commerce and Science College, Satana and Department of Chemistry, Mahant Jamnadas Maharaj Arts, Commerce and Science College, Karanjali, Taluka- Peth, District-Nashik. Affiliated to Savitribai Phule Pune University, Pune
2. To promote job oriented and skill based education of research through collaboration
3. To fill the gap of research activities and publication through collaboration
4. To encourage the students for internship/ project work /research activities through collaborative works.

Terms and Conditions of MOU

1. To organize the lectures for UG/PG students related nanomaterial synthesis, characterization and their application in various fields of science and technology
2. To share the knowledge / resources for publishing the research publications.
3. UG/PG students visit to the chemistry research laboratory to learn the synthesis process and characterization techniques of nanomaterials.
4. To publish the research papers of collaborative work into UGC-CARE listed/International standard peer reviewed journals.

5. To give motivation to the students/Faculties regarding research area
6. Presentation of research papers/project work/poster presentation organized under the institutes jointly or individually
7. The validity period of this MoU is from 01-01-2020 to 31-12-2025.

K.A.A.N.M.Sonawane Arts,Comm.& Sci.College SATANA 423301 NASHIK

Principal
Karm.Abasaheb Alias N.M.Sonawane
Arts, Commerce & Science College
SATANA, Tal.Baglan (Nashik)

Place: Karanjali

Date: 01/01/2020

।। स्वदेशे पुज्यते राजा विन्दान्सर्वत्र पुज्यते ।।
Govt. of Mah. Order No. N.G.C. 2009 (152/09) M.S.R - 4
Sahyadri Shikshan Mandal's, Dindori
Mahant Jamanadas Maharaj
ARTS, COMMERCE & SCIENCE COLLEGE
Karanjali, Tal. Peth, Dist. Nashik, (Maharashtra) 422 208. Ph.No. : 02558 - 234666
ID No. PU/NS/ACS/150/2009
E-mail : mjmcollege1@yahoo.com College Code - 908

Outward *No:-* 166 **/2016-17** ***Date:-*** **02/01/2017**

Memorandum Of Understanding (MoU)

Preamble:

Mahant Jamanadas Maharaj Arts Commerce And Science College,Karanjali,

Mahant Jamanadas Maharaj College of Arts Commerce And Science run by the Sahyadri Shikshan Mandal Dindori was established in 2009 by Honorable Shri Narhari Sitaram Zirwal, a great social worker and diplomatic political leader in Peth and Dindori. College is the only imparting higher education in Science to tribal, rural and economically backward students in Peth Taluka. The college is newly established in 11 July 2009 in Peth Taluka, Dist. Nasik. That time there were no educational facilities in Science at the taluka level and for higher education one had to go to district place which was not at all feasible for common man.

College is affiliated to Savitribai Phule Pune University, Pune. At present the college is running only undergraduate discipline. The major objectives of this college is to provide education to the masses from all spere, urban, rural and tribal Keeping with the vision and mission of the Savitribai Phule Pune University and our Sahyadri Shikshan Mandal, we have been putting in all efforts to provide quality higher education to keep our students abreast with the new demands of the changing world.

Jijamata of Arts, Commerce and Science, Bhende and Shri Dnyaneshwar Sahakari Sakhar Karkhana Ltd.

Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd., was established in 1973, in backward and project affected area of Jaikwadi Dam Irrigation Project of Ahmednagar District, under the able leadership of Late Marutrao Ghule Patil, the Founder Chairman of this Karkhana. The object of the sugar factory has not been remained to manufacture sugar from the sugarcane supplied by the farmers but now it has widened it's limitation, to achieve socio-economic development of the farmers as well as habitant of this area in the viscinity of the sugar factory. It has made progress in the educational field on the large scale. Educational institutions as well as technical institutes are established, With the help of this educational development of the rural area took place in the area of our factory.

With the clear understanding the pivotal role of Bio-fertilizer in Agriculture, a separate division, Jijamata College of Arts Commerce and Science had been established in 1992 at Bhende, Taluka Newasa. This College has been recognized under section 2(f) and 12(B) of the UGC Act, 1956 and affiliated to Savitribai Phule Pune University, Pune.

The memorandum of understanding is being signed between **Mahant Jamanadas Maharaj College of Arts Commerce And Science, Karanjali** and **Jijamata College of Arts Commerce and Science and Shri.Dnyaneshwar Sahakari Sakhar Karkhana Ltd, Bhende for mutual exchange of research knowledge** and for providing skill oriented persons to the industries.

Subject:

1. Biofertilizer Application, Soil and Water Analysis Prgrammes.
2. Jijamata College of Arts, Commerce and Science, Bhende, considers various courses to be very significant and important in enhancing the relevance of Degree education, since it will, among other things, provide skills for both boys and girls, which they can use either as gainfully employed persons or as self employed entrepreneurs.
3. Jijamata Colege of Arts, Commerce and Science, Bhende and Bio fertilizer Unit, is concerned and committed, to the success of the courses and agrees in this context to assist the college in whatever way they can. More specifically, the industry agrees to
    A. Provide guest faculty for teaching specific portions of the syllabus to the students.
    B. Assist students in the laboratory, workshop and training under supervision of professionals from the industry.
    C. Assist in preparation and production of teaching and learning materials for the use of faculty and students by leading the services from the professionals.
    D. The industry will arrange to the extent possible, training of the faculty of the college if and when called upon to do so.
    E. It will also arrange on-job training for the students in the manner to promote the knowledge and skill, which they can utilize for the performance of specific jobs.
    F. The industry will assist in the evaluation of student's performance in theory, laboratory, workshop, field work and on the job training.
    G. The industry will provide printed (including Xerox) and non-print materials available with them or that they can procure.
    H. The industry and the college both together possibly will work on a specific research project concerned with above mentioned fields.
    I. The college will provide skilled and knowledgeable persons to the industries or as per their requirements.
4. The two institutions will mutually decide upon the terms and conditions including financial support for the implementation of the above task.
5. We re-affirm our commitment to the courses and our willingness to make a consistent effort to ensure that they are implemented effectively and efficiently.
6. This MoU will be in force for ten years. After completion of ten years, it may extend after mutual concern of both the institutions.

PRINCIPAL
M. J. M. Art's, Commerce & Science College, Karanjali.

Signed on behalf of the institution seeking collaboration

PRINCIPAL
Jijamata College of Science & Arts
Dnyaneshwarnagar, Tal. Newasa

Signed on behalf of the institution providing support

सेक्रेटरी
श्री मारुतराव घुले पाटील शिक्षण संस्था,
ज्ञानेश्वरनगर, पो. भेंडे साखर कारखाना
ता. नेवासा, जि. अहमदनगर

Sahyadri Shikshan Mandal's,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

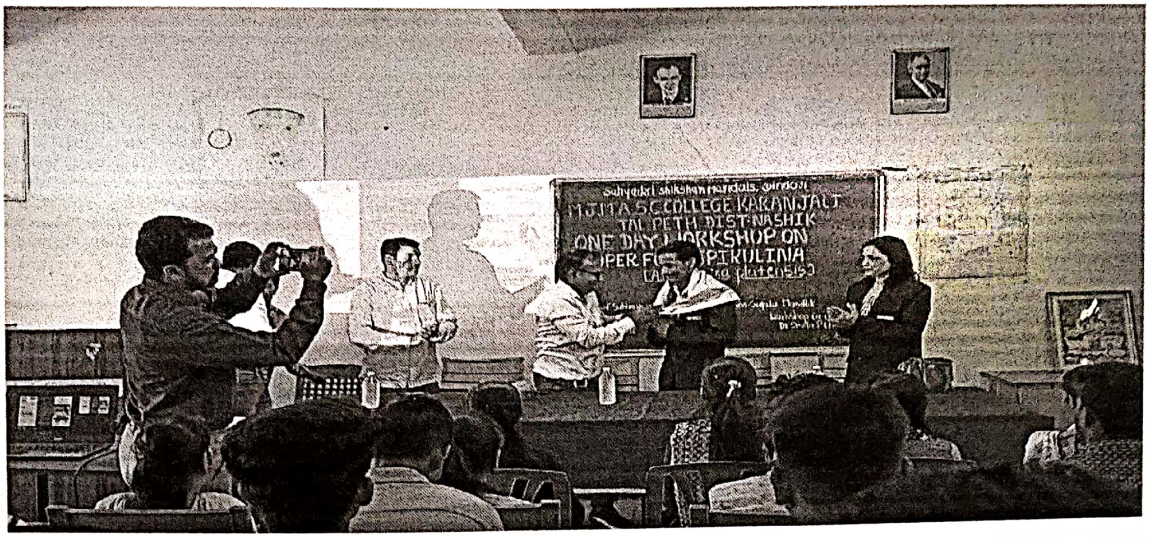
M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Botany

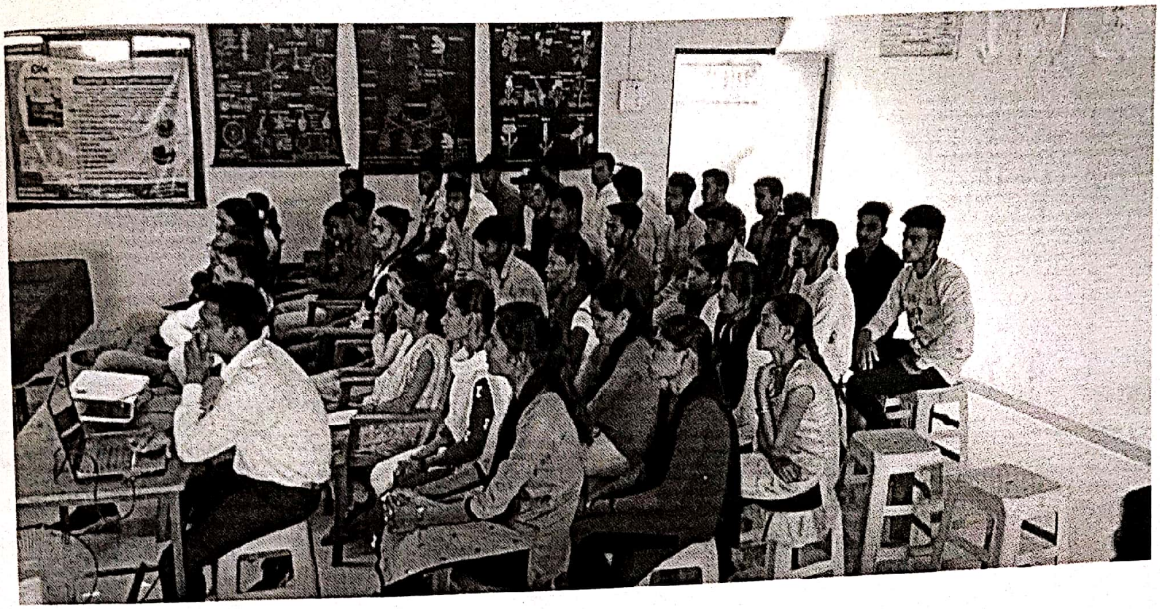
MOU Activity With

OM FOODS AND NATURALS, Tal- SANGAMNER, Dist-AHMEDNAGAR

MoU Activity 2022-2023

Department of Botany, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organized as One Day workshop on "Super Spirulina (*Arthrospira platensis*)" during 9th April, 2023.The inaugural programme initiated with welcome speech of Dr.M.S.Shinde, Principal of M.J.M . Arts Commerce and Science College Karanjali. In this program Chief Guest of Honorable Miss.ManjuMandlike Chairman of Om Foods And Nturals,Sangamner, delivered a lecture on "Super Spirulina its important in Human Health". He informed students spirulina are essential for daily life and if used in your daily life directly benefits your health.In this workshop Prof.SuabshVarpe was taken two sessions. In first session was take power point presentation about Super Sprirulina (*Arthrospira platensis*) and producer and second session it was taken demonstration about how to prepare and maintained in Super Sprirulina (*Arthrospira platensis*). The lecture was not only informative but also encouraged students Teachers and all the listeners to gain insight into financial planning. 85 students benefited from this interactive session.





Dr.M.S.Shinde
Principal
(Principal)
M.J.M. Arts Commerce & Science College Karajali, Tal.Peth, Dist.Nashik

Dr.A.S.Jondhale
(Head of Department)
Department of Botany
MJM Arts Commerce and Science College Karanjali

SahyadriShikshan Mandal's,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

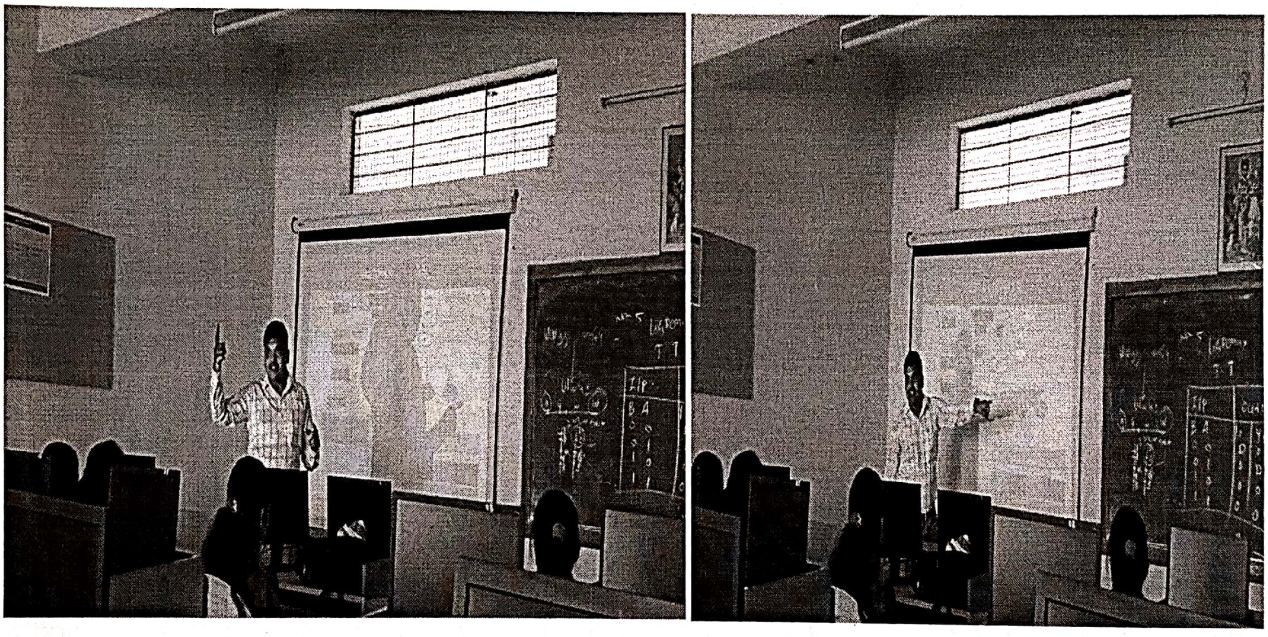
MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Botany

MOU Activity With

Department of BotanyJijamata College of Science and Arts Bhende Tal- NewasaDist-Ahmednagar.

MOU Under Lecture 2022-23



Dr.AvinashJondhale Delivering Lecture on Genetics at Jijamata Science and Arts College Bhende, Tal-Newasa, Dist-Ahmednagar for T.Y.B.Sc students of Botany, dated 07 November 2022.

Principal
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

R.No.ANR/PRG (A)- 5 (S) Date 19-10-1970 L.No.L 25 / N-281 / 73- LC Date 27-04-1973

लोकनेते मारूतराव घुले पाटील ज्ञानेश्वर सहकारी साखर कारखाना लि.,
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जा.क्र./Ref.No. 229/2022-23 दिनांक : 27/12/2022

CERTIFICATE

This is to certify that, ***Mr. Dalvi Tushar Shubhash*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on **"Mass Production of Bio-fertilizers".** During **23/12/ 2022 to 27/ 12/ 2022.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head
Soil, Biofertilizer and Biopesticide

Biofertilizer Laboratory
Loknete Marutrao Ghule Patil
Dnyaneshwar S.S.Karkhana Ltd.
Dnyaneshwarnagar, Po. Bhende S.K.
Tal. Newasa, Dist. A.Nagar-414605

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This is to certify that, *Mr. **Bhusare Rahul Manohar*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on "**Mass Production of Bio-fertilizers".** During **23/12/ 2022 to 27/ 12/ 2022.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head
Soil, Biofertilizer and Biopesticide

Biofertilizer Laboratory
Loknete Marutrao Ghule Patil
Dnyaneshwar S.S.Karkhana Ltd.
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Tal. Newasa, Dist. A.Nagar-414605

R.No.ANR/PRG (A)- 5 (S) Date 19-10-1970 L.No.L 25 / N-281 / 73- LC Date 27-04-1973

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CERTIFICATE

This is to certify that, ***Mr. Palvi Vishal Sudhakar*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on **"Mass Production of Bio-fertilizers".** During **23/12/ 2022 to 27/ 12/ 2022.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head
Soil, Biofertilizer and Biopesticide

Biofertilizer Laboratory
Loknete Marutrao Ghule Patil
Dnyaneshwar S.S.Karkhana Ltd.
Dnyaneshwarnagar, Po. Bhende S.K.
Tal. Newasa, Dist. A.Nagar-414605

SahyadriShikshan Mandal's,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

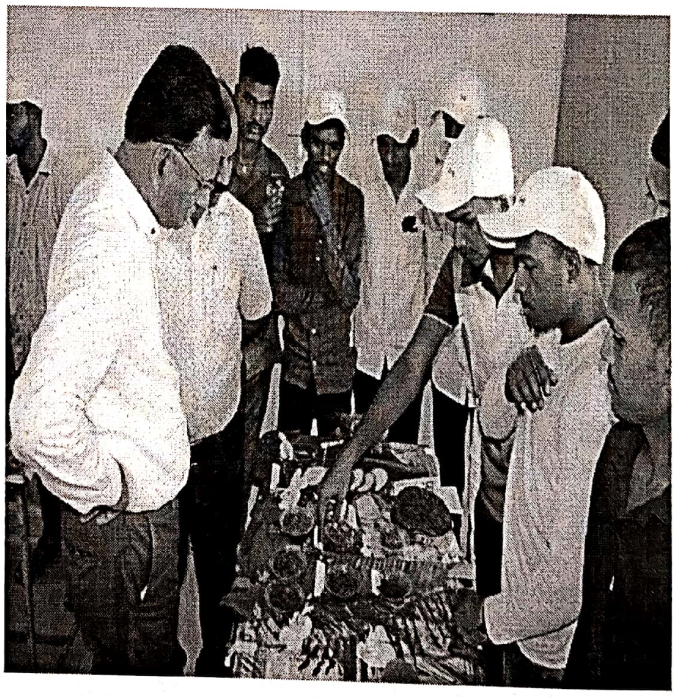
M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Botany

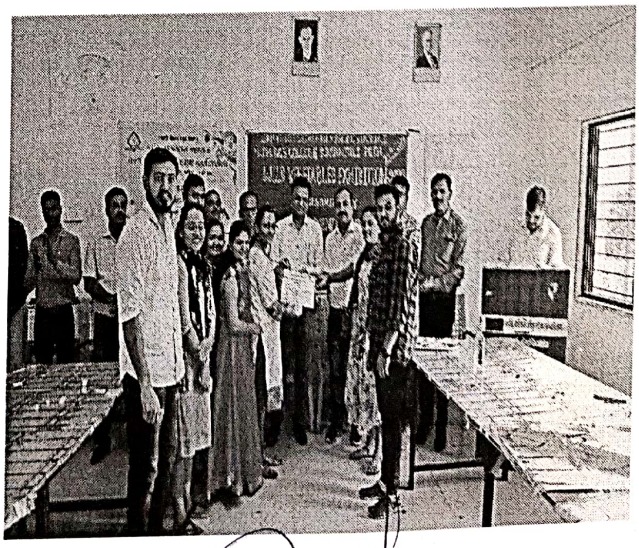
MOU Activity With

Department of Botany,Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar.

Department of Botany, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organized as One Day workshop Exhibition and Competition on "**Wild Vegetables Festival 2022**" during 29th September, 2022. In this program Chief Guest of Dr.B.D.Wagh, Vice-Principal Department of Botany Sahyadri Bhujan Vidya Prasarak Samj Shaakar Maharshi Bhausaheb Santuji Thorat College of Arts Science and Commerce, Sangamner, delivered a lecture on "Wild Vegetable Conservation and Utilization". He informed students wild vegetables are essential for daily life and if used in your daily life directly benefits your health. He also suggested to all participants the urgent need of wild vegetable plants for conservation. If we conserve and farm all this wild vegetable, then utilization is also increased. So, it is beneficial to farmers and the market value of this wild vegetable is higher as compared to other vegetable plants with good nutritional value. The lecture was not only informative but also encouraged students Teachers and all the listeners to gain insight into financial planning. 81 students benefited from this interactive session.

Principal
M.J.M. Arts, Commerce &
Science College Karajali,
Tal.Peth, Dist.Nashik





Principal
M.J.M. Arts, Commerce &
Karaiali,

लोकमत

करंजाळी महाविद्यालयात रानभाज्या महोत्सव

करंजाळी : पेठ तालुक्यातील करंजाळी येथील महंत जमनादास महाराज (एमजेएम) महाविद्यालयाच्या वनस्पतीशास्त्र विभागातर्फे रानभाज्या महोत्सव आयोजित करण्यात आला.

यावेळी डॉ. बी. डी. वाघ, डॉ. एम. टी. पाटील, डॉ. सतीश तांबे , प्रा. अशोक चौधरी आदी प्रमुख पाहुणे म्हणून उपस्थित होते. रानभाज्या महोत्सवासाठी विद्यार्थ्यांनी जवळपास वेगवेगळ्या ६० ते ७० रानभाज्यांच्या पाककृती बनवल्या होत्या. रानभाज्या महोत्सव यशस्वीतेसाठी संस्थेचे सचिव पकमाकर गवळी, प्राचार्य डॉ. महेंद्र शिंदे, डॉ. अविनाश जोंधळे , डॉ. स्मिता चव्हाण,डॉ. दीपक तायडे, डॉ. प्रकाश वानखेडकर, अशोक नागरे , विद्याधर गवळी, विजू ठाकरे, प्रकाश इंपाळ, सुनील गांगुर्डे परिश्रम घेतले.

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पुण्य नगरी

एमजेएम महाविद्यालयात रानभाज्या महोत्सव

करंजाळी : पेठ तालुक्यातील महंत जमनादास महाराज कला वाणिज्य आणि विज्ञान महाविद्यालयत वनस्पतीशास्त्र विभागातर्फे गुरुवारी (दि. २९) रानभाज्या महोत्सव आयोजित करण्यात आला होता. या रान भाज्या महोत्सवामध्ये नाशिक जिल्ह्यातून चांदवड महाविद्यालयातील, पंचवटी महाविद्यालयातील, त्र्यंबकेश्वर महाविद्यालयातील व एसएमबीटी महाविद्यालय संगमनेर येथून जवळपास ६० विद्यार्थी आणि विद्यार्थिनी सहभागी झाले होते.

या रानभाज्या महोत्सवासाठी प्रमुख अतिथी म्हणून एसएमबीटी संगमनेर महाविद्यालयाचे वनस्पतीशास्त्र विभाग प्रमुख डॉ. बी डी वाघ, चांदवड महाविद्यालयाचे वनस्पतीशास्त्र विभाग प्रमुख डॉ. एम. टी. पाटील, पंचवटी महाविद्यालयाचे वनस्पतीशास्त्र विभाग प्रमुख डॉ. सतीश तांबे व त्यांचे सहकारी तसेच त्र्यंबकेश्वर महाविद्यालयाचे प्रा. अशोक चौधरी हे सर्व प्रमुख पाहुणे म्हणून या कार्यक्रमाला उपस्थित होते. प्रमुख वक्ते म्हणून प्रा. सचिन गोलाईत होते येथील रानभाज्या महोत्सवासाठी विद्यार्थ्यां जवळपास वेगवेगळ्या ६० ते ७ रानभाज्यांच्या पाककृती तयार केल्ल होत्या. त्यामध्ये प्रामुख्याने अंबाडीच भाजी, तांदुळकाची भाजी, बांबूच भाजी, केळीच्या फुलांची भाजी हादग्याच्या फुलांची भजी, अळूवड आणि नागली, बाजरीची भाकरी अश वेगवेळ्या पाककृतींचा समावेश होत सहभागी सर्व विद्यार्थ्यांनी आलेल्ल पाहुण्यांना रानभाज्यांविषयी सविस्त माहिती दिली. पौष्टिक रानभाज्या तरु पिढीला जोपासता आल्या पाहिजे या उद्देशाने संस्थेचे सचिव पद्माक गवळी यांनी या महोत्सवासाठ पुढाकार घेतला होता.

रानभाज्या महोत्सव यशस्वीरित्या पार पडण्यासाठ संस्थेचे सचिव माननीय पद्माक गवळी, महाविद्यालयाचे प्राचार्य प्राध्यापकांनी परिश्रम घेतले. विद्याध गवळी, विजू ठाकरे, प्रकाश ईपाळ सुनील गांगुर्डे यांनी मोलाचे सहका केले. या रानभाज्या महोत्सवा आयोजन वनस्पतीशास्त्र विभागातीर विभाग प्रमुख डॉ. अविनाश जोंधळ आणि डॉ. स्मीता चव्हाण यां केले होते.

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Evaluation of organic pollution by palmer's algal index of kotmara reservoir in Sangamner (Ahmednagar) Maharashtra, India

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Abstract

The present study was conducted to assess the problem of organic pollution of Kotmara reservoir, Sangamner Taluka, Ahmednagar District, Maharashtra. Present investigation three different locations (K1, K2 and K3) were selected for collection of water algal samples. During the research work Palmer index, algal genus and algal species pollution index were employed to study the water quality of Kotmara reservoir. Palmer's Algal Index showed that K3 and K2 sites in Kotmara reservoir have high organic pollution. The K1 site Palmer's algal genus index showed moderate pollution, but Palmer's algal species index was little organic pollution. The predominance of genera with tolerance to pollution were Oscillatoria, Euglena, Chlorella, Phormidium, *Ankistodesmus*, *Scenedesmus*, Synedra and Navicula.

Keywords: palmer's index, algae, bio-indicators, pollution index and kotmara reservoir

Introduction

Kotmara fresh water reservoir (Ambidumala Project) is one of the important reservoirs near Ambidumala village of TalukaSangamner of Ahmednagar district. It is situated on Kas River and is a tributary of Mula River.The sources of water in Kotmara reservoir for surrounding the area of Ambidumala and Kurkutwadi village. The important purposes of this reservoir are used for drinking and irrigation purposes of farming in the total command area of Kotmara reservoir. But, there is a water degradation, because of the huge use of chemical fertilizers, washing in domestic animals, washing of cloths and sewage discharge waste material flow in this Kotmara reservoir. The water contamination mostly depends on the population of algae and inorganic chemicals are responsible for the growth of algale bodies. Wagh and Jondhale, (2018) [11] has been reported that human interference is directly effects on nature water reservoirs. Radhakrishnan *et al*., (2007) pointed out that almost 70% of water in India has become polluted due to the discharge of domestic sewage and industrial effluents into natural water sources such as rivers and streams as well as lakes. The natural water maintains a wide variety of aquatic life which is balanced with the environmental behaviors (Manoj and Pooja, 2012) [4]. Dokulil, (2003) [13], also reported that, water quality changes are caused by an environmental stress factors such as influx of organic nutrient into a low nutrient water body, there by altering the equilibrium state or dominance of particular bio-indicator species of algae community.

Therefore, algae are considered as very good bio-indicator of water quality due to their repaid response to pollutants. Alp, *et al*., (2012) [15] mentioned that algae are important biological organisms for purification of water bodies because they absorb organic and inorganic pollutants, heavy metals and radioactive substances. Similarly, Sushma and Ramesh, (2018) [10] observed that algae are one of the most rapid bio-indicator of water quality changes due to their short life spans, quick response to pollutants and easy to determine their numbers. So, individual species of algae are bio-indicators or tolerance of particular habitat and their ability to grow other algae under particular conditions of water quality. It was the first observed by the correlation between organic pollution with algal members (Pearsall, 1932) [8]. Palmer (1969) [6] first reported that they identify and prepare a list of genera and species of algae with reference to the tolerance of organic pollution. So, the study of algal bodies is essential for quality of water and it helps toverifying or understanding algae as a bio-indicators. Kotmara reservoir receives huge quantity chemical fertilizers, washing in domestic animals, washing of cloths and sewage results in organic pollution which encourages large number of disease spreading organisms. Based on above information and lack of organic and inorganic pollution assessment is essential for in Kotmara reservoir. Therefore, the present study was conducted to evaluate the organic pollution intensity and tolerance of algae in Kotmara reservoir by using Palmer's pollution scale.

Principal
M.J.M. Arts, Commerce &
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Tal.Peth, Dist.Nashik

I.Q.A.C. Co-ordinator
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

Sahyadri Shikshan Mandal,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

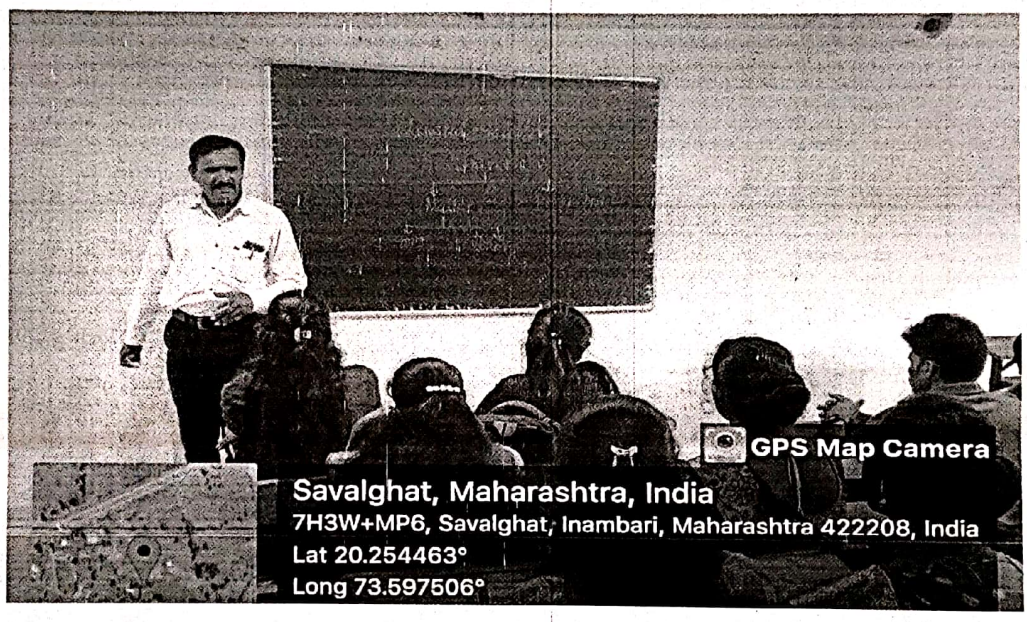
MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik,

Department of Chemistry

MOU Activity With

Department of Chemistry, Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar.



Department of Chemistry, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organized as Guest lecture on "**Cyclic Ring Structures**" during 24th August, 2022. In this program Prof. Dinkar Pawar, Department of Chemistry Sahyadri Bhujan Vidya Prasarak Samj Shaakar Maharshi Bhausaheb Santuji Thorat College of Arts Science and Commerce, Sangamner, delivered a lecture on "Cyclic Ring Structures". He introduce the basic chemistry regarding cyclic structures with their aromatic and nonaromatic nature and the stability of ring structures. The lecture was not only informative but also encouraged students Teachers and all the listeners to learn new things in cyclic compounds. 25 students benefited from this interactive session.

M.J.M.A.C.&S. College Karajali Tal.Peth, Dist.Nashik

Principal
M.J.M. Arts, Commerce & Science College Karajali, Tal.Peth, Dist.Nashik

॥ स्वदेशे पुज्यते राजा विन्दान्सर्वत्र पुज्यते ॥
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जावक क्र.: 179/2022-23 दिनांक : 30/09/2022

To

Prof.V.R.Pande
Head of Physics Department
SMBT Arts Commerce and Science College Sangamner.

Phy

Subject: -Delivery as a Resource Person Lecture in One-day Lecture Series ...

Dear Sir,

Thank you for visiting our college and delivering as a Resource Person Lecture in one day lecture series on 'Innovative Application in Physics' on Thursday, 30th September, 2022, from 1.00 am to 2.00 pm. I appreciate your cooperation and support to our college in improving academic quality.

Thanking you,

Yours sincerely,

Principal
M.J.M. Arts, Commerce and Science College
Karanjali, Nashik-422 208

M.J.M. COLLEGE KARANJALI TAL. PETH DIST. NASHIK

Principal
M.J.M. Arts, Commerce & Science College Karajali, Tal.Peth, Dist.Nashik

I.Q.A.C. Co-ordinator
M.J.M. Arts, Commerce and Science College
Karanjali, Nashik-422 208

।। स्वदेश पुज्यते राजा विद्वान सर्वत्र पुज्यते ।।
Govt. of Mah. Order No. N.G.C. 2009 (152/09) MS R - 4
Sahyadri Shikshan Mandal's Dindori
Mahant Jamanadas Maharaj
ARTS, COMMERCE & SCIENCE COLLEGE
Karanjali, Tal. Peth, Dist. Nashik. (Maharashtra) 422 208. Ph.No.: 02558 - 23666
E-mail : mjmcollege1@yahoo.com College Code - 908
ID No. PU/NS/ACS/150/2009
ID No. PUN ID-CAAN018750

जावक क्र.: 172/2022-23 दिनांक : 28/09/2022

To
Prof.V.R.Pande
Head of Physics Department
SMBT Arts Commerce and Science College Sangamner.

Subject: Invitation to work as guest lecture series for all science faculty Students...

Sir,

The Department of IQAC of, M.J.M Arts, Commerce and Science College, Karanjali, is arranged One day Guest lecture series on 30th September, 2022 for all science faculty students.

You are requested to accept our invitation to work as source person for delivering a lead lecture in the subject of "Innovative Application in Physics". Your lead lecture will be organized on 30th September, 2022 at 01.00 pm. Kindly send the bio-data of your lecture, at your earliest convenience.

Thanking You,

Yours sincerely,

M.J.M. COLLEGE KARANJALI TAL. PETH. DIST. NASHIK

Principal
M.J.M. Arts, Commerce and Science College
Karanjali, Nashik-422 208

Principal
M.J.M. Arts, Commerce &
Science College Karajali,
Tal.Peth, Dist.Nashik

I.Q.A.C. Co-ordinator
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208

SahyadriShikshanMandal's,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Physics

MOU Activity With

Department of Physics,SahyadriBhujanVidyaPrasarakSamj, SahakarMaharshiBhausahebSantujiThorat College of Arts, Science and Commerce Tal-Sangamner, Dist-Ahmednagar.

Department of Physics, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organized lecture series on **"Innovative applications in Physics"** on 30th September, 2022. In this program Chief Guest Prof. VijaykumarPande, Head, Department of Physicsof SahyadriBhujanVidyaPrasarakSamjShaakarMaharshiBhausahebSantujiThorat College of Arts Science and Commerce, Sangamner, delivered a lecture on **"Innovative applications in Physics"**.

He informed students with different innovative ideas like **Renewable Energy Models** to demonstrate the working principles of renewable energy sources like solar panels, wind turbines, or hydroelectric generators.**Electromagnetic Induction**illustrate Faraday's law of electromagnetic induction, showing how a changing magnetic field can induce an electric current in a wire coil ,**Optical Illusions** concepts like refraction, reflection, or the behavior of light in different mediums.**Simple Machines** like pulleys, levers, or inclined planes to showcase mechanical advantage.**Radio Waves and Communication** waves how are they transmitted and received. The lecture was not only informative but also encouraged students Teachers and all the listeners to gain insight into financial planning. 35 students benefited from this interactive

session. This session was highly appreciated by the fellow participants.For the said lectureDr.M.S.Shinde, Prof. KavitaBorse were present. The informative and skilful workshop culminated with a vote of thanks proposed by the Dr.M.S.shinde.

Head
Dept. of Physics
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Mahant Jamanadas Maharaj
Arts, Commerce And Science College, Karanjali (Peth)

M.J.M. Arts, Commerce and Science College, Karanjali, Nashik
Physics

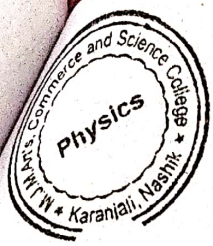
"INNOVATIVE APPLICATIONS IN PHYSICS"

Date: 30th September, 2022.

Attendance of Participants

1	Bhusare Roshan Jagan	T.Y.B.Sc.	
2	Fasale Bhagwan Prabhakar	T.Y.B.Sc.	
3	Gawali Harshad Manohar	T.Y.B.Sc.	
4	Waghmare Premdas Kalidas	T.Y.B.Sc.	
5	Padvi Prakash Ramesh	T.Y.B.Sc.	
6	Bhoye Ravindra Vasant	T.Y.B.Sc.	
7	Gaikwad Milind Sampat	T.Y.B.Sc.	
8	Thepane Nitin Kamalakar	T.Y.B.Sc.	
9	Bhadange Dushant Prabhakar	S.Y.B.Sc.	
10	Chaudhari Nilima Parashram	S.Y.B.Sc.	
11	Mahale Dayanand Pandurang	S.Y.B.Sc.	
12	Chauhan Vishal Pundalik	S.Y.B.Sc.	
13	Impal Laxmi Devidas	S.Y.B.Sc.	
14	Saini Sanjaykumar Hemraj	S.Y.B.Sc.	
15	Bhivsan Dipak Dinkar	S.Y.B.Sc.	
16	Mahale Gitanjali Tukaram	S.Y.B.Sc.	

17	Bhamare Mayur Devendra	S.Y.B.Sc.	M.B.Bh
18	Pagare Asmika Santosh	S.Y.B.Sc.	A.S.Pagare
19	Mahale Pranjali Laxman	S.Y.B.Sc.	Mahale
20	Wani Prasad Anil	S.Y.B.Sc.	Wani
21	Gawali Laxman Nivrutti	S.Y.B.Sc.	Gawali
22	Shardul Abhishek Ramkant	S.Y.B.Sc.	Shardul
23	Gawali Harshad Yuvraj	F.Y.B.Sc.	Gawali
24	Patade Sakshi Baban	F.Y.B.Sc.	Patade
25	Bhoye Harshad Jagannath	F.Y.B.Sc.	Bhoye
26	Bhusare Sandip Uttamrao	F.Y.B.Sc.	SBhusare
27	Pawar Amruta Ashok	F.Y.B.Sc.	Pawar
28	Gavali Chandrakala Prabhakar	F.Y.B.Sc.	Gavali
29	Chaudhari Narendra Dilip	F.Y.B.Sc.	Chaudhari
30	Pawar Sunil Janardan	F.Y.B.Sc.	Pawar
31	Chaudhari Jivandas Ramesh	F.Y.B.Sc.	Chaudhari
32	Patil Tushar Prakash	F.Y.B.Sc.	Patil
33	Khambait Dipak Shamrao	F.Y.B.Sc.	Khambait
34	Jadhav Yogesh Hiraman	F.Y.B.Sc.	Jadhav
35	Bhorsat Renuka Purushottam	F.Y.B.Sc.	Bhorsat
36	Shinde Umesh Ravindra	F.Y.B.Sc.	Shinde



37	Chaudhari Prachi Vitthal	F.Y.B.Sc	Chaudhari
38	Kilbile Nitin Hiraman	F.Y.B.Sc.	
39	Boke Gorakh Bala	F.Y.B.Sc	
40	Potarde Pankaj Suresh	F.Y.B.Sc.	

I.Q.A.C. Co-ordinator
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Principal
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Science College Karajali,
Tal.Peth, Dist.Nashik

Sahyadri Shikshan Mandal's

M.J.M. Arts, Commerce & Science College, Karanjali

Department of Mathematics

Report of the Activity 2022-23

1. Name of the Activity: - Lecture for exchange of knowledge under MOU
2. Aim of the Activity: -
   - To make students aware with "innovative Applications in Mathematics".
3. Place of the Activity: -

   Department of Mathematics, M.J.M. Arts, Commerce and Science College Karanjali Tal-Peth Dist. -Nashik
4. Date of the Activity: - 29/09/2022

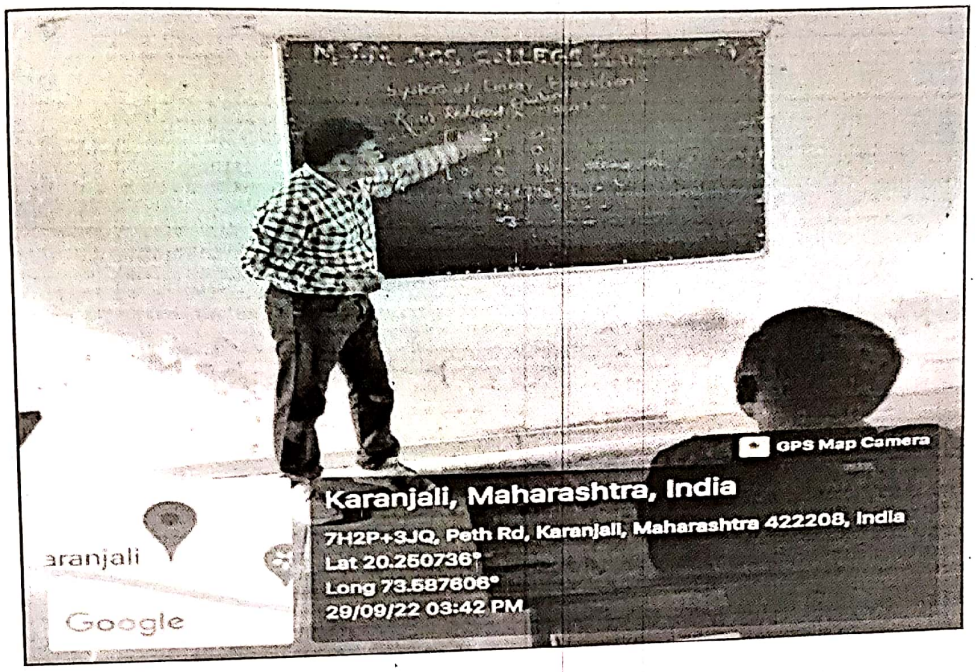
5.Organizer: Department of Mathematics, M.J.M. Arts, Commerce and Science College Karanjali Tal-Peth Dist. –Nashik.

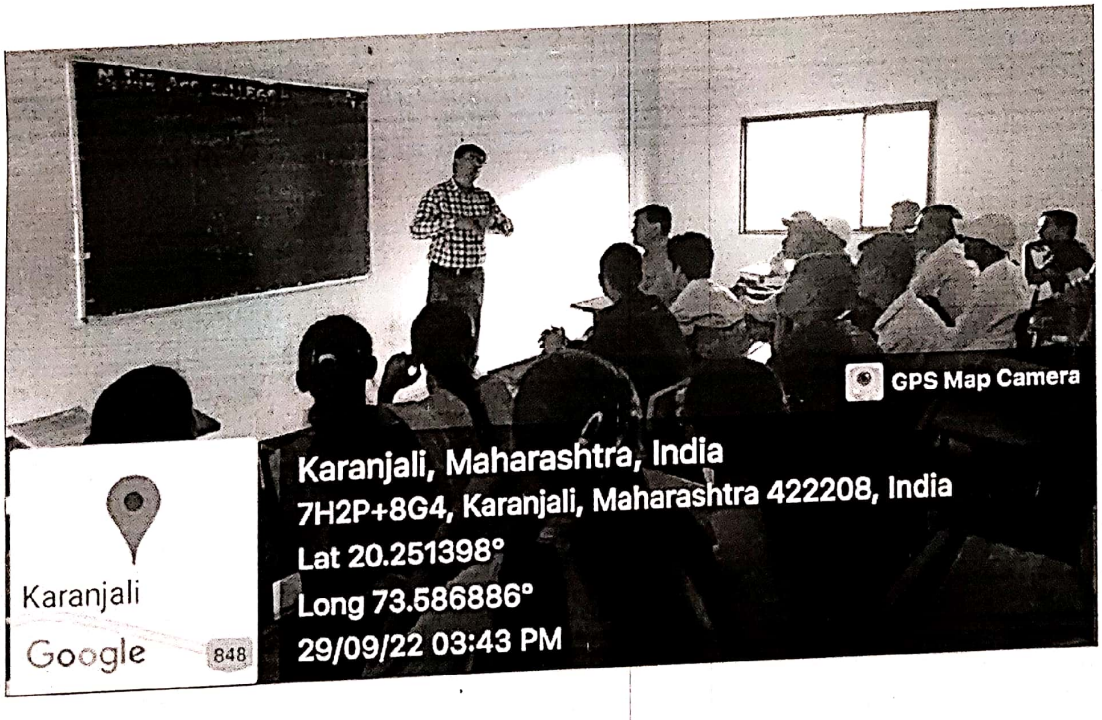
6.Guest / Expert: - Dr. Milind M. Sakalkale.

7. No. of Teacher Participated: - 02
8. No. of Students Participated: -25
9. No. of Stakeholders Participated: - --
10. Outcome of the Program: -
    a. Students made aware with new applications like Maxima Software in Mathematics.
    b. Now students can solve various examples using Maxima Software.
11. Highlight if any: -

Head
Dept. of Mathematics
M.J.M.Art's Comm.& Sci.College
Karanjali, Tal. Peth (Nashik)

Principal
M.J.M. Arts, Commerce &
Science College Karajali,
Tal.Peth, Dist.Nashik





Sahyadri Shikshan Mandal's

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

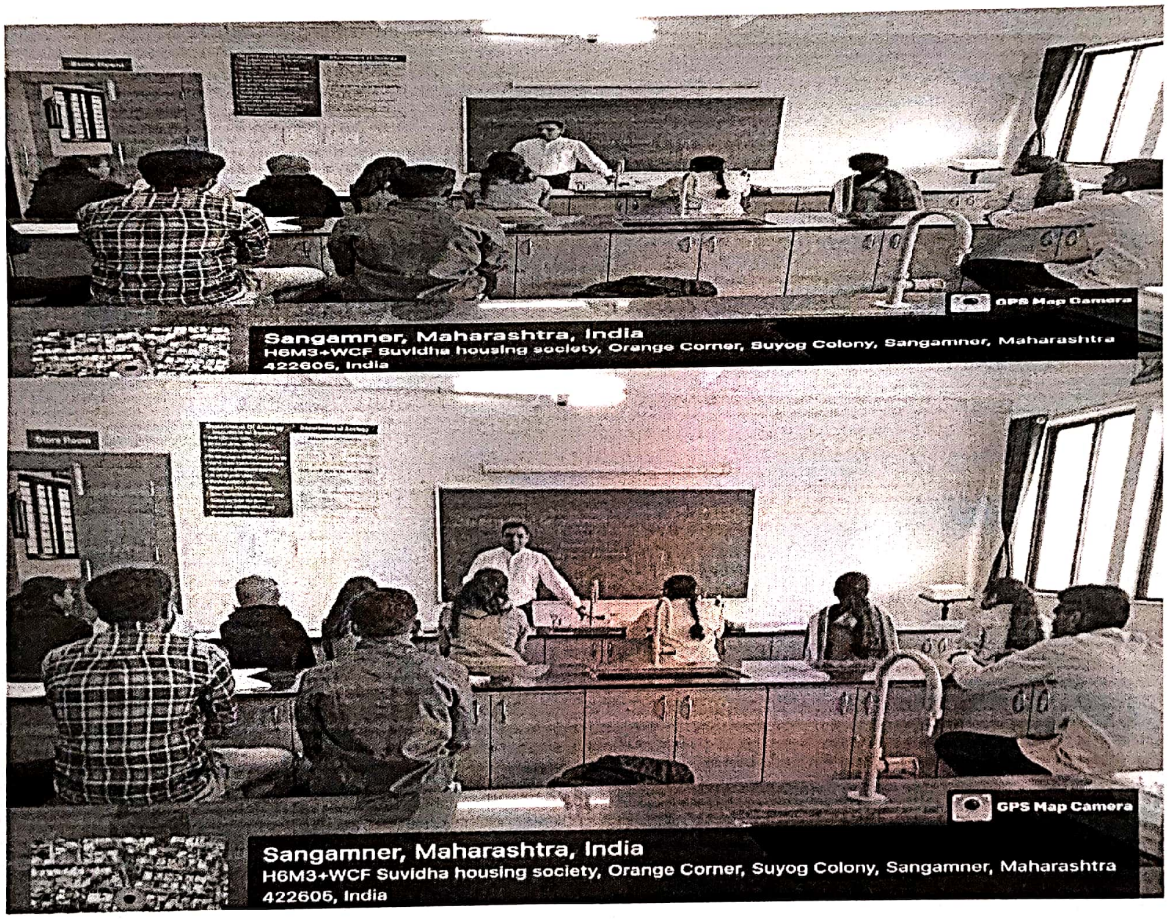
MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Zoology

MOU Activity With

Department ofZoologyDepartment of Botany, Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar

MOU Under Lecture 2022-23



Dr.Niranjan Giri Delivering Lecture on "Seri-Culture" at Department of Zoology, Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar, dated 18/01/2023

Principal
M.J.M. Arts, Commerce & Science College Karajali, Tal.Peth, Dist.Nashik

Head
Dept. of Zoology
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Karanjali, Tal : Peth (Nasik)

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ID No. PU/NS/ACS/150/2009

जावक क्र.:

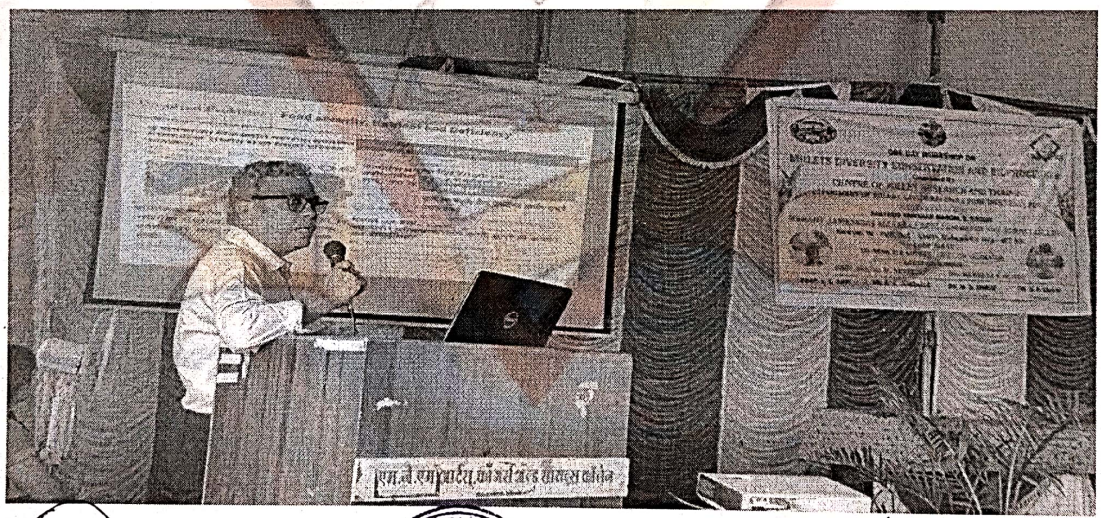
दिनांक :

Workshop Title: Millet Diversity Conservation and Bioprocessing

Jointly organized by HPT Arts and RYK Science College, Nashik-422005

And MJM Arts Commerce and Science College, Karanjali, Peth, Nashik.

Department of Botany, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali and HPT Arts and RYK Science College Jointly organized as One Day workshop on "Millet Diversity Conservation and Bioprocessing" during 14th March, 2023.The inaugural programme initiated with welcome speech of Dr.M.S.Shinde, Principal of M.J.M .Arts Commerce and Science College Karanjali. Chief Guest of this workshop for Honorable Dr.S.G.Auti, Head of Botany Department in HPT Arts and RYK Science College Nashik. Dr.S.G.Auti delivered a lecture on "Finger millet cultivation and promotion". During workshop 65 students participated in this workshop.



Dr.M.S.Shinde
(Principal)
M.J.M. Arts, Commerce and Science College
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Dr.A.S.Jondhale
(Head of Department)
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Allelopathic effect of weed extracts on seed germination of finger millet

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(Received 11 September, 2022; Accepted 9 November, 2022)

ABSTRACT

Finger millet is a nutritious food grain crop with a fair amount of minerals like calcium and iron. Present investigation deals with the allelopathic effect of *Parthenium hysterophorus* and *Lantana camara* on germination and seedling vigour in finger millet. Seeds of the finger millet were subjected to different concentrations of leaf aqueous extracts of *Parthenium hysterophorus* and *Lantana camara* (4%, 6%, 8%, 10%, 25%, 50% and 75%) to find out allelopathic effects on Total germination percentage (GT), Plant height stress tolerance index (PHSI), Root length stress tolerance index (RLSI), Peak value (PV), Germination value (GV). Experimental results revealed that leaf extract of *Parthenium* showed profound allelopathic effect on seeds of the finger millet over to *Lantana camera*. The present study helps farmers to be aware with the lethal allelopathic effect of obnoxious weeds like *Parthenium* and *Lantana*.

Key words : *Parthenium hysterophorus, Lantana camara, Allelochemicals, Allelopathic, Finger millet, Leaf extract.*

Introduction

Allelopathy refers to any process involving secondary metabolites produced by plants, micro-organisms, fungi etc. that positively or negatively influence the growth and development of agricultural and biological systems. These allelochemicals are released into the environment (atmosphere or rhizosphere) in ample quantities by means of volatilization, leaching, decomposition of residues, root exudation etc. and if persistent long enough could either stimulate or inhibit the growth and physiological processes of the neighbouring or successional plant (Putnam, 1988; Inderjit and Keating, 1998). The higher concentrations of allelochemicals usually inhibit the growth of recipient plants and soil microorganisms or both. In nature, many plants growing together interact with each other by inhibiting or stimulating growth and development of each other through allelopathic interactions (Macias *et al.*, 1998). The different types of allelochemicals present in weeds, reduces the crop yield and quality (Zohaib *et al.*, 2016; Latif *et al.*, 2017). Weeding in crops increases the cost of cultivation and is great problem for the farmers (Cheng and Cheng, 2015). Hence, biological control of weeds through understanding the weed-weed and crop-weed interactions is important research area (Mervat, 2009). Currently, crop performance, which is suppressed by allelopathic weeds, has received more attention in order to control weeds in farming systems.*Lantana camara* and *Parthenium hysterophorus* are the America originated weeds belonging to family Verbenaceae and Asteraceae. It has spread to the other regions of world including India. *Lantana camera* was introduced in India from National Botanical Gardens, Calcutta in 1807 as an ornamental plant and parthenium in 1952 in Pune. The *Parthenium*

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(*Parthenium hysterophorus* L.) and *Lantana* (*Lantana camera*) is a common weed on roadsides, wastelands and crop fields. It interferes with the growth of crops, not only due to its fast growth and high seed production but also due to release of allelochemicals in the environment. The most common effects of the allelochemicals on the plant are reduction in percent germination and rate of germination, reduction in root or/ and stem length injuring of the root tips, lack of chlorophyll, boost seminal root, decline dry matter accumulation, increased sterility in crop (Bhadoria, 2011). *P. hysterophorus* can also affect crop production, animal husbandry as well as human health and ecosystems in its area of infestation (Nadeem *et al.*, 2005; Shabbir and Bajwa, 2006). Effect of *Parthenium* and *Lantana* extracts on seed germination and seedling growth inhibition of many crops have been reported in Wheat (*Triticum aestivum*) (Naeem *et al.*, 2012; Anwar *et al.*, 2018; Muhammad Imad *et al.*, 2021), *Cicer arietinum*, *Glycine max* (Rana *et al.*, 2021), *Abelmoschus esculentus* (Akbar *et al.*, 2021), *Brassica campestris* (Hassan *et al.*, 2018) and maize (Desalegn, 2014).

Finger millet (*Eleusine coracana*) is an annual herbaceous cereal crop belonging to family poaceae. It is commonly known as ragi and one of the important millet crops grown for grain and fodder purpose under varied agro-climatic conditions in India. Finger millet is rich in calcium, dietary fibre, protein, iron, zinc, essential amino acids than other major food crops (Gupta *et al.*, 2017; Sood *et al.*, 2016). The grain is used as flour in the preparation of cakes, bread and other pastry products and serves as a beneficial food for infants (Ceasar and Ignacimuthu, 2011). Finger millet has nutritional properties superior to that of rice and wheat, so it has been proposed to help in strengthening the nutritional security in the developing countries of Asia and Africa (Puranik *et al.*, 2017). Aim of the present investigation was to study the allelopathic potential of aqueous leaf extracts of *Lantana camara* and *Parthenium hysterophorus* on seed germination and early growth of the economically important food crop finger millet.

Materials and Methods

Collection and Extraction of Plant Material

Fresh plant material was collected from the H. P. T. College campus and nearby areas of Nasik. Plant was correctly identified with the flora of Maharashtra (Singh *et al.*, 2000) and flora of Nashik district (Lakshminarasimhan and Sharma, 1991). Plant material was washed under running tap water and dried under shade. It was than homogenized into powder with electric blender and different stock solutions were prepared for further studies.

Preparation of Aqueous Extract

The aqueous extracts were prepared from dry leaves of weeds (*Lantana camara*, *Parthenium hysterophorus*). 300 gm of dry leaves powder were soaked in 300 ml of distilled water and kept at room temperature. After 24 hours, the aqueous extract was filtered with the help of muslin cloth. The filtrate was designated as 100 % stock solution. From this stock solution other concentration were prepared such as 4%, 6%, 8%, 10%, 25%, 50% and 75% by diluting it with distilled water.

Germination Test

Seeds of finger millet (Red and white) were first washed with distilled water and after that sterilized with 15% sodium hypochlorite for 20 min. The seeds were soaked for 24 hours in distilled water before treatment. Three replicates in a completely randomized design, each containing 25 seeds of finger millet was prepared for each extract concentration using sterile petri dishes (9 cm diameter) lined with sterile Whatman No. 1 filter paper. Seeds were evenly distributed on the filter paper and aqueous extract solution was added to each petri dish. The seeds used as controls were treated with only distilled water. After two weeks different parameters were recorded daily such as, Total germination percentage (GP), Plant height stress tolerance index (PHSI), and Root length stress tolerance index (RLSI). The samples were calculated using the formula below.

Germination percentage

$$GP = \frac{\text{Seed germinated}}{\text{Total seeds}} \times 100$$

Plant Height Stress Tolerance Index (PHSI)

$$PHSI = \frac{\text{Plant height of stressed plants}}{\text{Plant height of control plants}} \times 100$$

Root Length Stress Tolerance Index (RLSI)

$$RLSI = \frac{\text{Root length of stressed plants}}{\text{Root length of control plant}} \times 100$$

Results and Discussion

Effect of *Parthenium hysterophorus* and *Lantana camera* aqueous leaf extract on finger millet (Red and white)

The aqueous extracts of leaves of *Lantana camara* and *Parthenium hysterophorus* have been evaluated at 4% to 75% for their allelopathic potential on germination (Table 1) and seedling growth parameters (Table 2) of two varities (red and white) of finger millet. The allelopathic effect of *Parthenium* and *Lantana* on total germination percentage, root and shoot length is shown in Table 1 and 2.

The result show that seed germination of Finger millet (red and white) was found to be decreased with the increasing concentration of *P. hysterophorus* extract. Seed germination was observed more at control as compare to treated seed.

The results reveal that *Parthenium* extract significantly decreased growth parameters of root and shoot length of red and white finger millet. Shoot length was gradually decreased by increasing concentrations of *Parthenium* extract. Slightly increased concentration (4%) of *Parthenium* extract stimulates the growth of shoot. 4% extract shows maximum shoot growth (166 % and 168 %) in red and white finger millet as compare to control (100 %).

In case of *Lantana camera*, seed germination was gradually decreased by increasing concentration of aqueous extract of *Lantana camera* at all concentrations as compared to control in both white and red finger millet variety. After control treatment, maximum shoot (250 %) and root (257 %) length was found in red finger millet variety at 25 and 50 % respectively. While higher (75 %) concentration was totally inhibiting the growth of root and shoot as compared to non-treated seeds. On other hand, slightly increased (8 %) concentration showed maximum (263 %) root growth and higher concentration shows maximum (166 %) shoot growth of white finger millet.

Discussion

Lantana camara and *Parthenium hysterophorus* are the America originated weeds and have spread to the other regions of world including India, threaten ecological biodiversity in forest ecosystems by their huge proliferation in any place at any time thus it exerts negative effects on agriculture, animal husbandry, ecology and environment in natural and managed ecosystems (Ahmed *et al.*, 2007). *P. hysterophorus* is widely regarded as the most vicious weed due to its toxic effects both to humans and to biodiversity (Kaur *et al.*, 2014). Due to presence of toxic chemicals, there are strong allelopathic effects on various crops and its allelopathic conditions hampered the germination and growth of agricultural crops such as wheat, rice, maize, pigeon pea, sorghum and black gram (Meena *et al.*, 2017). In most dicot and monocot plants, the parthenin inhibits germination and radicle growth. Later, it enters the soil through the decaying leaf debris (Saini *et al.*, 2014).

In the present study, *Parthenium hysterophorus* and *Lantana camera* extract was found to inhibit significantly seed germination of tested white and red finger millet variety. Similar observations were recorded in *P. hysterophorus* extract concentration on *Cicer arietinum* (Fozia *et al.*, 2020), *Vigna radiata* (Lalita *et al.*, 2020), wheat, rice, maize, pigeon pea, sorghum, and black gram (Meena *et al.*, 2017), Hassan *et al.* (2018) reported a significant effect of *Parthenium* extract on seed germination of some crops. A slightly increased (4 %) concentration of

Table 1. Effect of *Parthenium* and *Lantana* on total seed germination

Parameter	No of Days	4%	6%	8%	10%	25%	50%	75%	Control
	10	Effect of *Parthenium* extract on finger millet (white variety)							
		84%	76%	72%	84%	24%	-	-	85%
GP Total germination percentage		Effect of *Lantana* extract on finger millet (white) variety							
		72%	92%	80%	96%	64%	68%	48%	96%
		Effect of *Parthenium* extract on finger millet (red variety)							
		94%	94%	90%	60%	20%	-	-	95%
		Effect of *Lantana* extract on finger millet (red variety)							
		100%	100%	95%	90%	60%	55%	20%	100%

Table 2. Effect of *Parthenium* and *Lantana* on Seedling Growth

Crop	Type of weed	Extract concentration	Germination percentage	Root length	Shoot length
Finger millet (red)	*Parthenium hysterophorus*	4 %	94 %	125	166
		6%	94%	50	33.36
		8%	90%	116.66	133
		10%	60%	58.33	100
		25%	20%	-	-
		50 %	-	-	-
		75 %	-	-	-
		Control	95%	100	100
Finger millet (white)		4 %	84%	-	168
		6%	76%	-	160
		8%	72%	-	91
		10%	84%	-	120
		25%	24%	-	40
		50 %	-	-	-
		75 %	-	-	-
		Control	85%	100	100
Finger millet (red)	*Lantana camera*	4 %	100%	185	75
		6%	100%	214	75
		8%	95%	200	100
		10%	90%	242	125
		25%	60%	257	100
		50 %	55%	142	250
		75 %	20%	-	-
		Control	100%	100	100
Finger millet (white)		4 %	72%	227.27	100
		6%	92%	204.54	164
		8%	80%	263.63	140
		10%	96%	231.81	100
		25%	64%	172.72	106
		50 %	68%	145.45	116
		75 %	48%	113.63	166
		Control	96%	100	100

Parthenium extract was stimulatory effect of shoot and root growth. Maximum shoot and root growth was observed as compared to control. Rashid *et al.* (2008) also reported the stimulation of shoot length with a slight dose treatment. The present findings suggest that the release of allelochemicals in low amounts stimulates growth, while greater amounts result in inhibition of other plants. Gindri *et al.* (2020) reported that all tested aqueous concentrations of *Lantana camara* affected seed germination of *Avena sativa*.

Conclusion

The present experimental study results show that *Parthenium* and *Lantana* had strong allelopathic effects on seed germination and seedling growth of white and red finger millet variety. Its aqueous extract phytotoxicity increased with concentration. Higher concentration of both aqueous extract shows inhibitory effect in both varieties. Further study will be identifying the exact allelochemicals in the weeds which promote the growth of the test crop.

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Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Botany

MOU Activity With

Department of Botany, Shri.Neminath Jain Brahmacharyaashram, Karmaveer K.H.Abad Arts Shriman M.G.Lodha Commerce and Shriman P.H.Jain Science College, Neminagar, Chandwad,Dist-Nashik, Maharashtra-423101.

2022-23

MOU Under

Students Participated in Workshop On Wild Vegetables Preparation in Chandwad College.

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"STUDIES ON GAS SENSITIVITY OF CADMIUM SULPHIDE (CdS) THIN FILMS".

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Abstract:

Nanocrystalline semiconducting Cadmium Sulphide (CdS) thin films were deposited on glass substrate by relatively simple, quick and cost effective chemical bath route. The deposition kinetics played important role to get good quality nanocrystalline films with uniform thickness. By optimizing preparative parameters uniform film have been obtained. The characterization of as deposited thin films was carried out for the structural, compositional, surface morphological, and gas sensing properties using X-ray diffraction (XRD), Scanning electron microscopy (SEM) and Gas sensing static unit.

Gas sensing responses of the nanocrystalline CdS thin films were measured by exposing as deposited film to different gases like carbon dioxide (CO_2), Hydrogen sulphide (H_2S) and Chlorine (Cl_2). It was found that the CdS thin film sensors exhibited a high sensitivity and good selectivity to Chlorine (Cl_2) gas at 500 ppm and CdS thin film can be used as a new type of gas sensing material.

Keywords: Thin films, Cadmium Sulphide, Nanocrystalline, *gas sensing, selectivity.*

1. Introduction

Nanocrystalline Cadmium Sulphide (CdS) belongs to I-IV group compound of semiconducting material. Its band gap varies between 1.2 to 2.5 eV. The CdS thin films have wide range of well perspective applications such as field effect transistors, light emmiting diodes, photocatalysis and biological sensors [1-2] optical coding optical data storage and sensing [3,4], nonlinear integregated optical device [5]. In recent years there has been growing interest in developing techniques for preparing semiconductor nanoparticles and thin films because the properties in nano form differ significantly from those of their bulk counter parts [6,7]. Therefore much effort has been made to control the size, morphology and crystallinity of CdS thin film. For the deposition of CdS thin films both gas phase and liquid phase methods have been used. Gas phase deposition method includes vacuum evaporation, flash evaporation, activated

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evaporation(ARE),sputtering and chemical vapor deposition(CVD) whereas liquid phase includes electrodeposition [8], electroless deposition, successive ionic layer adsorption and reaction (SILAR) [9,10], chemical bath deposition(CBD) [11-14]. Among them, chemical bath deposition (CBD) is well known as a low temperature aqueous technique for depositing large area of semiconductor thin films. It is very simple, cost effective and also capable in growing nanocrystals, microcrystal and epitaxial structure under various growth condition.

Preciously we have reported the synthesis of CdS thin films by different route [15]. In present investigation CdS thin films have been deposited using chemical bath deposition method in alkaline bath. The structural, compositional, surface morphological and optical properties of the as deposited CdS thin films were studied.

2. Experimental details

The deposition was carried out by using Corning glass slides (25mm X 75mm X 1mm) as substrate which were initially boiled in concentrated chromic acid for 30 min. rinsed in acetone, deionised water and finally ultrasonically cleaned. All analytical grade (A.R) reagents were used as it is without further purification for the deposition of CdS thin films.Aqueous solution of 0.1M Cadmium sulphate, 0.1M thiourea and complexing agent Liq. Ammonia and C_2H_5OH was used. Initially 20ml of CdSO4 solution , 2.5 ml liq. ammonia and 1ml C_2H_5OH was placed in 50 ml beaker, after stirring for several minutes solution becomes dark purple and homogeneous under continuous stirring , 15 ml ml thiourea solution was introduced then cleaned glass substrate were vertically immersed into the prepared bath at room temperature. Preparative parameters are optimized for best quality CdS film.

3. Characterization Techniques

The structural characterization of the films was carried out using Philips (PW-3710) X-ray diffractometer with CuKα radiation (α= 1.5404°A) in 2θ range from 20^0-80^0. The surface morphological study of ZnS films was carried out by scanning electron microscopy using a Model JOEL, JSM 6360 A. Gas sensing performance was measured by homemade static gas sensing unit.

4. Result and discussion

4.1 Structural studies

X-ray diffraction patterns of the film were recorded on Model Bruker D8 advance AXS X-ray diffractometer with scanning angles in the range 20 – 80 degree using CuK_α radiation (λ=1.5406 Å).

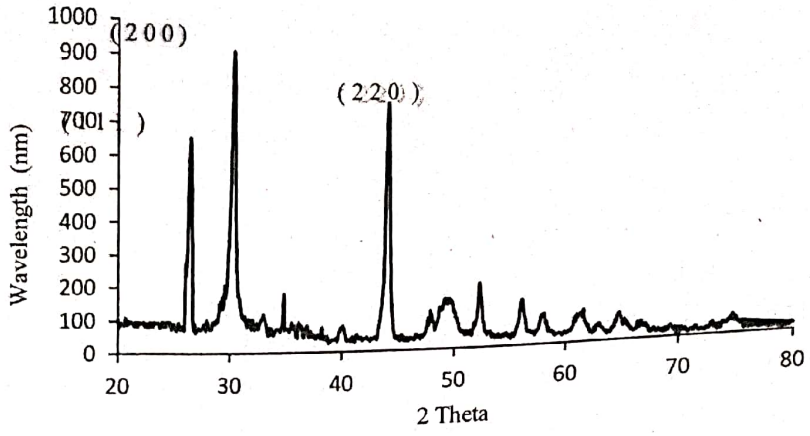

Fig. 1 : X-ray diffraction pattern of as-deposited CdS thin films For different thicknesses on glass substrate at room temperature.

Fig.1 shows X-ray diffraction pattern of as-deposited CdS thin film on glass substrate by chemical bath deposition method. In the present diffraction pattern of XRD, four dominant peaks at 26.5°, 30.7°, 44.0° and 52.1° corresponding to the (111), (2 0 0) and (2 2 0) planes of CdS are seen with cubic crystal structure [14]. An average value of the crystallite size can be obtained by applying the Debye-Scherrer's equation, D = $0.9\lambda/\beta\cos\theta$ where, λ=1.5406 Å for CuKα, β is the full width at half maximum (FWHM) of the peak and θ is the diffraction/Bragg's angle. The sample as-deposited CdS resulted in an average crystallite size of approximately 90 nm.

4.2 Surface morphological studies

Scanning electron microscopy (SEM) is a versatile technique for studying microstructure of thin films. The CdS thin film with 250 nm thickness was used to study the surface morphology using a scanning electron microscopy.

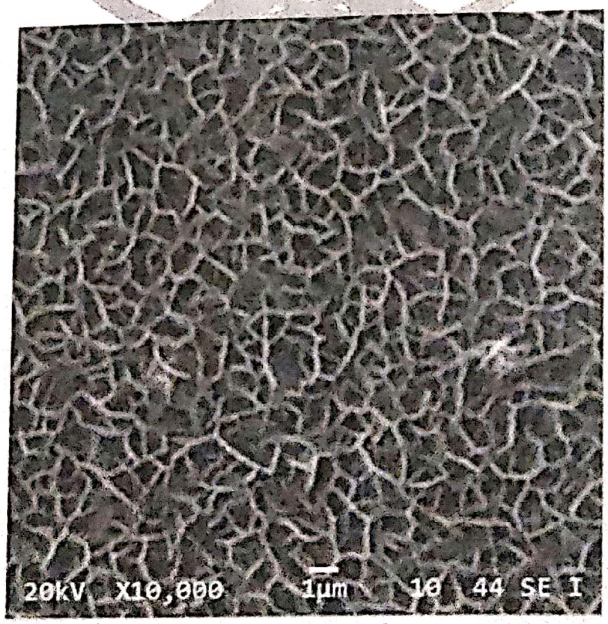

Fig. 2: The surface morphology of as-deposited CdS on glass substrate at room temperature by scanning electron microscopy studies.

Fig. 2 shows a scanning electron microscope of CdS thin film at X 10000 magnification the scale bar len is 1μm the average grain size of CdS thin films is 120nm which was estimated using Cotrells methods [18] The as-deposited film shows net like nanostructure with symmetry in shape. The film surface looks smooth and uniform. It was observed that the film was uniform Yellowish and well substrate covered.

4.3. Sensing Performance

4.3.1. Measurement of Gas response, Selectivity

The gas-sensing properties of CdS thin films to different gases Carbon dioxide (CO_2), Hydrogen Sulphide (H_2S) and chlorine (Cl_2) were studied. Sensitivity (S) or Gas response is measured as the ratio of change in resistance of the sensor on exposure of the target gas to the original resistance in air medium using relation

$$\text{Sensitivity S (\%)} = \frac{Ra - Rg}{Ra} \times 100 \quad \text{..... (1)}$$

Where *Ra* is the stabilized resistance of sensor in air medium and *Rg* is the resistance in the presence of target gas and selectivity or specificity is measured, as the ability of a sensor to respond to certain gas in the presence of more gases.

Fig. 3 depicts the variation gas responses as function of operating temperature of nanocrystalline CdS thin films for different gases with 500 ppm concentration.

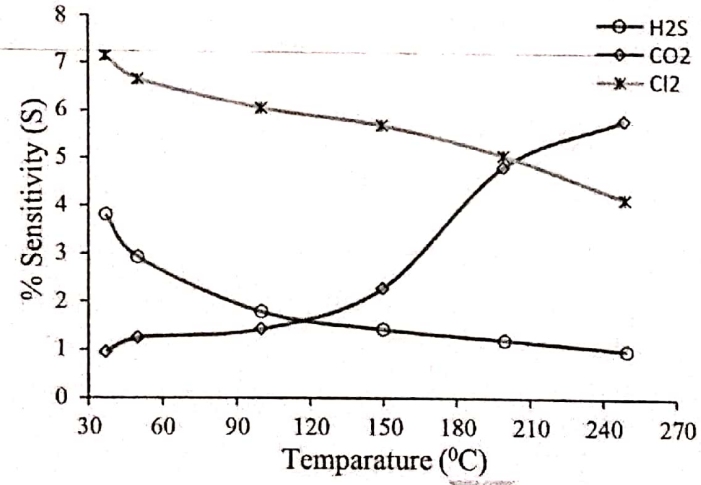

Fig. 3: Variation of gas response as function of operating temperature.

From **Fig. 4** it is observed that nanocrystalline CdS thin film sensor shows high sensitivity at room temperature for H_2S gas. The sensitivity for Cl_2 increase with increase in temperature but in case of CO_2 the behavior of thin film sensor is completely reverse. .

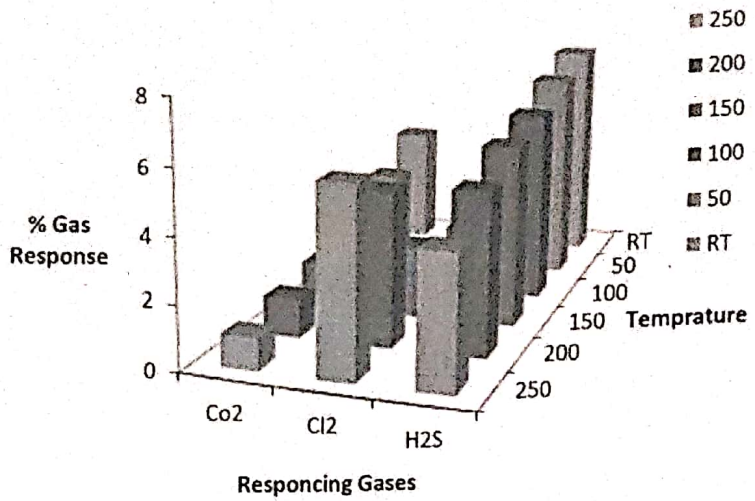

Fig. 4: Variation of gas response with operating temperature for CdS thin film gas sensor for different gases.

4.3. 2 Selectivity for Cl_2 Against Various Gases

The gas response of nanocrystalline CdS thin film sensor was tested for H_2S Cl_2 , and CO_2.

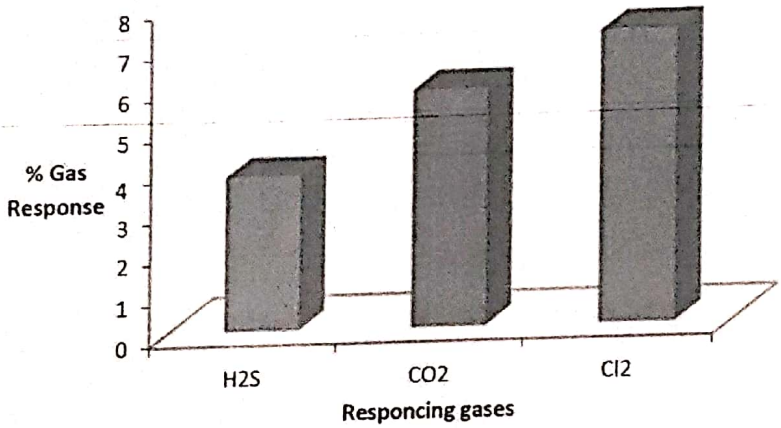

Fig. 5 Selectivity of CdS thin films for various gases at 500 ppm gas concentration .

It is observed from **Fig. 5** that the nanocrystalline **CdS** sensor gives maximum response to **Cl_2** gas at room temperature. The nanocrystalline **CdS** thin film sensor showed highest selectivity for **Cl_2** among all other tested gases.

Conclusion

The XRD study of as deposited nanocrystalline CdS thin films by CBD route on glass substrate showed the cubic structure partical size 90nm. The SEM micrograph reveals that substrate is well covered and average grain size is 120 nm. The investigated gas sensing responce of CdS thin film for Carbon dioxide (CO_2), Hydrogen Sulphide (H_2S) and chlorine (Cl_2). The CdS thin film sensor shows fast response and a good recovery times . The results demonstrated that nanocrystalline CdS thin film can be used as a new type of gas sensing material which has a high sensitivity and good selectivity to chlorine (Cl_2) gas at 500 ppm.

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Exploration of photocatalytic performance of TiO_2, 5% Ni/TiO_2, and 5% Fe/TiO_2 for degradation of eosine blue dye: Comparative study

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ABSTRACT

In the present investigation, the TiO_2, 5 % Fe/TiO_2, and 5 % Ni/TiO_2 were successfully synthesized by the co-precipitation (CPT) method. The synthesized undoped and doped TiO_2 nanomaterials were employed for photocatalytic degradation of eosine blue dye in the aqueous heterogeneous suspension. X-ray powder diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS), High resolution transmission electron microscopy (HRTEM), X-ray photoelectron spectroscopy (XPS), and Brunauer–Emmett–Teller (BET) analyses were performed to investigate the crystallinity, surface morphology, elemental composition, crystal lattice, chemical state of the elements, and surface area of the fabricated photocatalysts, respectively. XRD indicated that TiO_2 nanoparticles are formed in the anatase phase. HR-TEM pictures clearly showed that synthesized material as a tetragonal anatase crystal lattice. The BET analysis revealed that 5 % Fe/TiO_2 material has an enhanced surface area of 80.98 m^2/g. The oxidation states of Fe^{3+} and Ni^{2+} were confirmed based on XPS investigation. The experimental parameters like nanocatalyst dosage, pH of the solution, initial concentration of dye, light intensity, and contact time were studied. The photocatalysis results revealed that dye removal in acidic pH was greater than in neutral and alkaline pH. Photocatalyst efficiency of dye degradation was found to be increased with the increase in nanocatalyst dose, light intensity, and contact time. The photo induced degradation (96.45 %) of eosine blue dye is more efficient at a minimum dose of 5 % Fe/TiO_2 nanocatalyst (0.8 g/L) at the optimum conditions of pH 7.0, and contact time 110 min.

1. Introduction

Nanostructured semiconductors have been known for their great potential for environmental remediation due to photocatalytic oxidation, which is induced by solar light or UV light [1–4]. Recently several studies reveal that the wastewater released from the manufacturing industries such as plastic [5], textile [6,7], coatings [8], paints [9,10], inks [11,12], etc. contains many organic pollutants which directly enter the environment. These organic pollutants are hard to degrade and removal is difficult naturally, causing several problems and risks to the aquatic ecosystem and mankind [13–15]. Several traditional methods have been proposed for wastewater treatments viz. adsorption, biological, membrane filtration, coagulation, and advanced oxidation process (AOPs) [16–26]. However, some of these methods may not always be very efficient or feasible.

In recent years AOPs gain more attention because of their low-cost, chemical stability, non-toxic, and ease of handling [27–29]. In this economical process, functional semiconductors act as a photocatalyst was irradiated with UV light. The electron-hole pairs (e^-, h^+) resulted from the electronic excitation from the valance band to the conduction

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band in the semiconductor. These electron-hole pairs (e^-, h^+) produced the active species hydroxyl radicals [30–33]. These processes are surface phenomena, which convert the organic pollutants, adsorbed on the surface of photocatalyst into less hazardous compounds like H_2O, CO_2, and other organic products [34–36]. Among the semiconductors, titanium dioxide (TiO_2) has received more attention due to its remarkable functional properties like thermal stability, inexpensive, safety, non-toxicity, and efficiency to oxidize several organic pollutants at room temperature [37–40]. The literature study also reveals that TiO_2 photocatalysis is an effective method for decolourization and oxidation of dyes in wastewater. Despite the wide energy gap (3.2 eV) which requires the high energy of excitations and addition the fast recombination of electron-hole pairs are two major drawbacks of using TiO_2 [41–43]. Hence modifications of TiO_2 were carried out to achieve the objectives and enhance this process so that UV light can activate the TiO_2 and lower the recombination of electron-hole. To overcome such drawbacks different methods like doping of transition metals with TiO_2 [44]. Doping has been a proven efficient method and doping with selective metal dopants can tune the band gap of titanium dioxide [45–48]. The nanocatalyst with lower band gap energy can be possible with the incorporation of metals with TiO_2, the transition metals like Fe, Ni, Zn, Cr, etc. are found effective for successful doping, which aims a higher photon absorption [49–52]. Still, we met with several disadvantages like declined redox potential of the designed semiconductor photocatalyst, charge recombination by incorporated metal ion canters, and less thermal stability that declines the photocatalytic performance of the modified photocatalyst. Thus the effect of doping on the catalytic performance of TiO_2 photocatalyst is part of the research interest [53,54]. Hence investigation could be useful in addressing the efficient nanocatalyst and improving our ideas to use these nanomaterials.

In the present investigations the transition metal Fe, and Ni-doped TiO_2 nanocatalyst were employed for the decolorization of EB solutions. The series of photocatalysis experiments using undoped TiO_2, 5 % Fe/ TiO_2, and 5 % Ni/TiO_2 was performed by varying experimental parameters like contact time, initial dye concentration, pH, and catalyst dose. Further, this study also reveals that modified TiO_2 photocatalyst was employed in the aqueous solutions suspensions to get photocatalyst with high surface area, and enhanced contact among the photocatalyst and the organic molecules (pollutant) to ensure the enhanced photocatalytic removal and comparative study. Nano TiO_2, Fe/ TiO_2, and Ni/ TiO_2 powder were separated from the solutions by centrifugation of post-treatment solutions. The isolated aqueous solutions containing eosine blue as a pollutant were investigated for the effect of the number of operating parameters on the efficiency of dye removal. Further, various analytical techniques like XRD, XPS, HR-SEM, EDS, HR-TEM, and BET were applied to explore the structural characteristics of the photocatalyst.

2. Materials and methods

The chemicals consumed in the present research work for the fabrication of titanium dioxide are purchased from Sigma-Aldrich Mumbai. The chemicals used in the present research are used without any further process like purification etc. Chemicals used are titanium isopropoxide, Ferric nitrate, nickel nitrate, NaOH, and deionized water.

2.1. Preparation of pristine TiO_2 nanoparticles by CPT method

The titanium dioxide nanoparticles were prepared by cost-effective co-precipitation method. For this synthesis titanium isopropoxide was used as a basic compound to fabricate the titanium dioxide nanoparticles. Initially, stoichiometric mole concentration (0.01 mol) of titanium isopropoxide was used to initiate the reaction. The calculated mole concentration of the titanium source was added slowly (drop-wise) to the 20 ml of deionized water. This water and titanium precursor mixture resulted in hydrolysis of the alkoxide and finally precipitated as

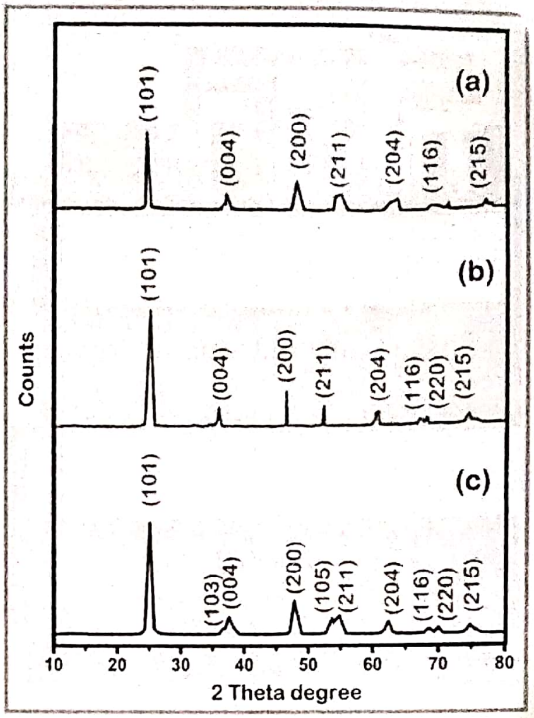

Fig. 1. (a) XRD pattern of undoped TiO_2 photocatalyst, (b) XRD pattern of 5% Fe/TiO_2 photocatalyst, (c) XRD pattern of 5% Ni/TiO_2 photocatalyst.

hydrous titanium precursor. This solution was then thoroughly mixed by constant stirring at a low temperature of about 70–80 °C for nearly 40 min. The white precipitate of titanium hydroxide precursor was settled at the bottom of the beaker, which was separated by the centrifugation method. The titanium precursor was centrifuged at 300 rpm for 300 s. The precipitate was washed with hot water and ethanol, and then dried in an oven at 100 °C overnight. The dried titanium precursor powder was then subjected to calcination under a muffle furnace at 450 °C nearly for 5 h. The titanium dioxide nanoparticles were recovered from the muffle furnace for further use.

2.2. Synthesis of 5 % Fe/TiO_2 and 5 % Ni/TiO_2 nanoparticles by CPT method

For the synthesis of 5 % Fe/TiO_2 and 5 % Ni/TiO_2 nanoparticles, the same method as explained in section 2.1 was followed. But, additionally, 5 % dopant concentration of each dopant metal precursors i.e., Fe and Ni salts were added to the solution of titanium isopropoxide. The remaining same procedure was followed for the synthesis of 5 % Fe/TiO_2 and 5 % Ni/TiO_2 nanoparticles. The greyish-coloured modified titanium dioxide nanoparticles were obtained from the muffle furnace.

2.3. Photocatalysis study of eosine dye for modified TiO_2 catalysts

The photocatalysis of undoped TiO_2, iron-modified TiO_2, and nickel-modified TiO_2 over eosine blue (EB) dye was examined using the obtained materials. A Photocatalytic reactor fitted with a 260 Watt mercury lamp was used to investigate the photocatalytic degradation of EB dye. A magnetic stirrer, a water chiller, a safety cabinet with a control panel, and a double jacket quartz immersion well are all included in the reactor. The overall dye concentration varied a much throughout the experiment. A double-beam UV-spectrophotometer with a UV range of 200–800 nm was used to measure changes in EB dye concentration. Another important factor that determines whether dye degrades in acidic or basic environments is the pH. Glass electrodes were used to

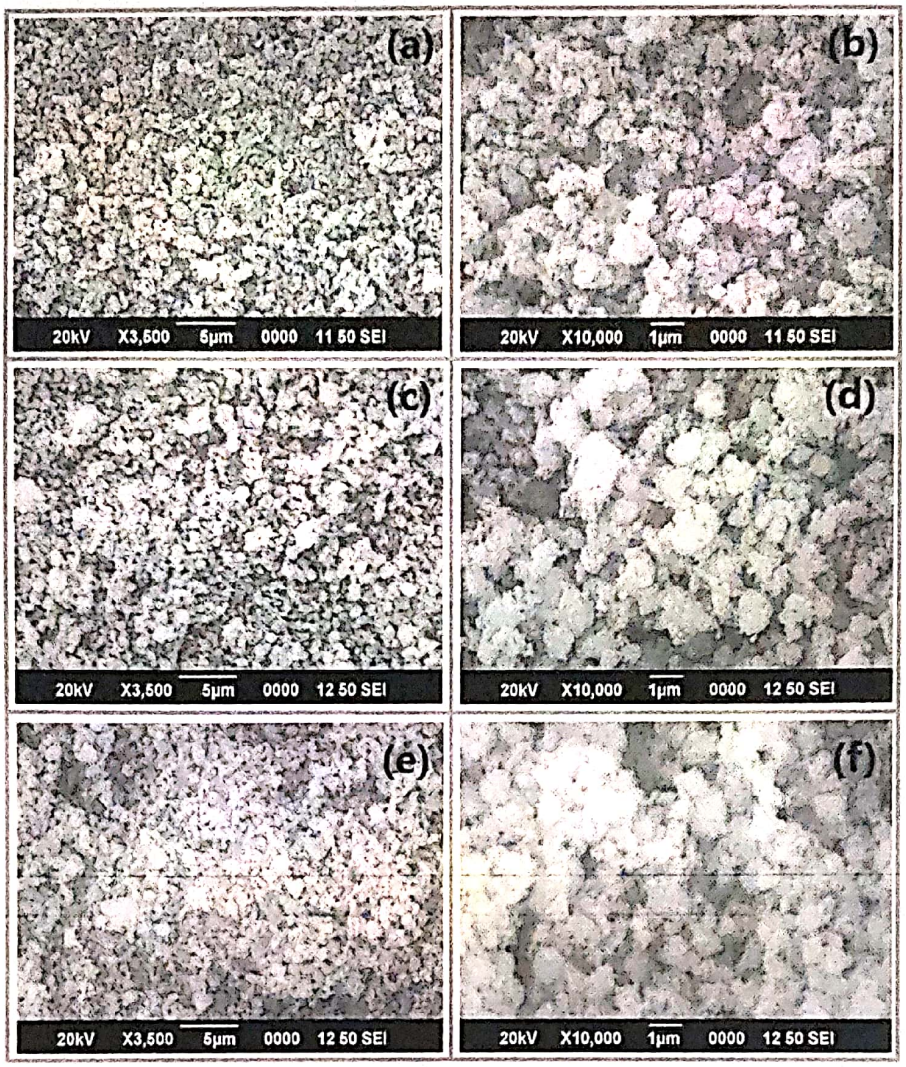

Fig. 2. (a,b) SEM images of undoped TiO_2 photocatalyst (c,d) SEM images of 5% Fe/TiO_2 photocatalyst, (e,f) SEM images of 5% Ni/TiO_2 photocatalyst.

detect the pH using a digital pH meter made in India. The buffer solution of pH 3, 9, and 12 was used to normalize the pH meter before use. To avoid the interference of catalyst molecules, the final absorbance of the supernatant dye solutions was measured after centrifugation. The photocatalytic degradation of EB dye was calculated from Equation (1)

$$\%D = \frac{(Co - Ct)}{Co} \times 100 \quad (1)$$

where C_o = Initial concentration and C_t = concentration at time t.

C_0 is the initial concentration of EB dye and C_t is the concentration of EB dye at time t.

3. Results and discussion

3.1. X-ray diffraction analysis

The undoped TiO_2, 5 % Fe/TiO_2 and 5 % Ni/TiO_2 materials were characterized using a Bruker D8 advanced X-ray diffractometer with a Braggs scanning angle of 10–900. Fig. 1 a-c depicts the XRD spectrum of all produced materials. The distinct Braggs reflection peaks that can be assigned to the fabrication of TiO_2 nanomaterial are shown in Fig. 1 a-c. Although TiO_2 can be found in three different phases: anatase, rutile, and brookite, 2θ values for different Bragg's reflection peaks indicate that TiO_2 nanoparticles are formed in the anatase phase [55–57]. The anatase TiO_2 crystal structure does not change much with doping concentrations of elements Fe^{3+} and Ni^{2+}, as seen in XRD peaks. Although the little alteration or shifting of 2θ values of 5 % Fe/TiO_2 and 5 % Ni/TiO_2 nanoparticles can easily be detected that indicates that the TiO_2 material has been slightly modified due to doping since elemental doping causes several lattice modifications in the host molecule, such as crystal defects, oxygen vacancies, F-centres, edge dislocations, and so on. The 2θ values of diffraction peaks revealed from XRD data for TiO_2; 25.08, 37.58, 47.78, 53.67, 54.80, 62.42, 68.52, 70.00, 74.79 are marked to the reflection of (001), (004), (200), (105), (211), (204), (116), (220) and (215) planes. The diffraction peaks for 2θ values and hkl planes aforesaid supports the formation of anatase TiO_2 nanomaterial. The JCPDS data cart number 21-1272 justifies the formation of TiO_2 material. Similarly, the XRD spectrum of 5 % Fe/TiO_2 nanomaterial have 2θ values 25.15, 37.65, 47.85, 53.74, 54.86, 62.48, 68.57, 70.06, 74.85, indicating slight shifting of two theta values that are assigned to the (001), (004), (200), (105), (211), (204), (116), (220) and (2015) planes. The 2θ values revealed from the XRD spectrum of 5 % Ni/TiO_2 nanomaterials has also indicated the shifting to slightly lower 2θ values in comparison to the undoped TiO_2 and 5 % Fe/TiO_2 nanomaterials. The 2θ values can be assigned as 24.92, 37.42, 47.61, 53.53, 54.62, 62.28, 68.39, 69.81, and 74.65 to the reflection of (001), (004), (200), (105),

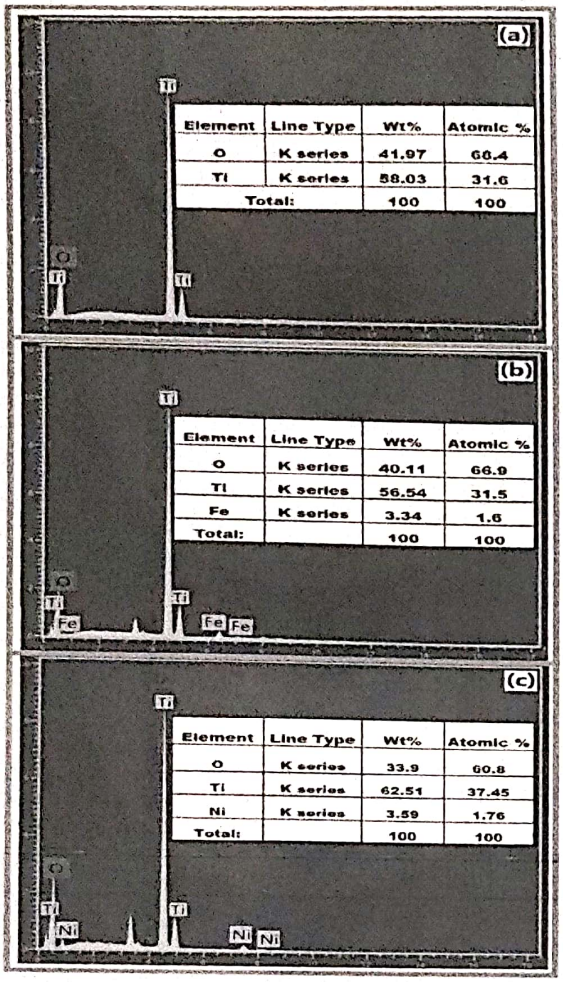

Fig. 3. (a) EDS spectrum of undoped TiO_2 photocatalyst, (b) EDS spectrum of 5% Fe/TiO_2 photocatalyst, (c) EDS spectrum of 5% Ni/TiO_2 photocatalyst.

(211), (204), (116), (220) and (215) planes. The average particle size was calculated by using Debye- Scherer's formula given in equation (2)

$$D = \frac{K\lambda}{\beta COS\theta} \quad (2)$$

where D is average particle size, K is constant (0.9 to 1), β is full width half maxima (FWHM) of diffracted peak, θ is the angle of diffraction. The average particle size of undoped TiO_2 nanomaterial calculated using equation (1) is found to be 18.33 nm, For 5 % Fe/TiO_2 nanomaterial, it was 16.70 nm and for 5 % Ni/TiO_2 nanomaterial, it was found to be 16.97 nm.

3.2. High resolution scanning electron Microscopy: (HR-SEM)

Fig. 2 a-f shows SEM images of the three produced materials, namely undoped TiO_2, 5 % Fe/TiO_2, and 5 % Ni/TiO_2 nanomaterials. Surface micrographs of undoped TiO_2 showed a tight aggregation of small nanoparticles with a heterogeneous and uniform porous surface across the TiO_2crystal lattice. Small lumps, holes, and small pits can be seen between the agglomerations due to the tight aggregation of diverse size nanoparticles. Nanomaterials' smaller spaces are the most important traits for boosting adsorption-related capabilities of solid materials, especially for sensors. Fig. 2 c-d shows SEM pictures of a different material, 5 % Fe/TiO_2 nanomaterial. A smaller cluster of nanoparticle lumps with a heterogeneous surface can be seen in the images. Bec the material appears to be more porous in nature, with smaller spaces over the crystal lattice, the 5 % Fe/TiO_2 has been observed to have larger surface area. Similarly, the SEM images of 5 % Ni/TiO_2 nanomaterials shown in Fig. 2 e-f show microscopic nanoparticles scattered throughout the crystal structure. This material also has a heterogeneous surface area, with nanoscopic vacancies forming throughout the 5 % Ni/TiO_2 lattice due to near aggregation of small nanoparticles, which improves the material's surface characteristics and makes it a suitable photocatalyst. As also evident from BET analysis, 5 % Fe/TiO_2 has a better surface area than undoped TiO_2 and 5 % Ni/TiO_2, which is likely due to smaller crystallite size, porous nature and crystal vacancies in the case of 5 % Fe/TiO_2 making good porosity possessing material with improved surface area.

3.3. Energy dispersive spectroscopy (EDS)

EDS analysis was used to confirm the elemental composition of undoped TiO_2, 5 % Fe/TiO_2, and 5 % Ni/TiO_2. Fig. 3 a-c shows the EDS spectrum of the prepared materials, which shows the resolution elements on the EDS scale and their elemental makeup. Fig. 3-a shows that titanium elements are strongly resoluted at 4.5 eV in an undoped TiO_2 material. Fig. 3-b shows the elemental composition and features a resolution of elemental iron and titanium in 5 % Fe/TiO_2. The sharp resolution of Ti at 4.5 eV and 6.5 eV EDS scales for iron are seen in Fig. 3-b. Fig. 3-c shows the EDS spectrum of 5 % Ni/TiO_2. The elemental Ni is resoluted around 8 eV, whereas the titanium is on the same scale of 4.5 eV. The elemental Fe and Ni are successfully doped over the crystal lattice in their substantial elemental composition, according to the EDS spectra of all the materials. The actual concentration of Fe and Ni in doped nanomaterials was found to be less due to the less solubility of the dopant TiO_2 material. The XPS technique also backs up the EDS findings.

3.4. High-resolution transmission electron microscopy (HR-TEM)

High-resolution transmission electron microscopy was used to examine the crystal lattice of all synthesized nanomaterials. Fig. 4-a-f shows HR-TEM images of undoped TiO_2, 5 % Fe/TiO_2, and 5 % Ni/TiO_2. nanomaterials. The HR-TEM mapping images indicated diverse-sized - nanomaterials ranging from 17 to 40 nm, confirming the crystallite size determined by XRD data. Furthermore, nearly all TEM pictures showed the tetragonal tetragonal anatase crystal lattice of undoped and doped TiO_2 materials.

3.5. Brunauer-Emmett-Teller (BET) study

The BET study was used to determine the surface area of the fabricated material using nitrogen adsorption–desorption experiments on all three synthesized photocatalysts. Photocatalysis is an adsorption phenomenon, with dye molecules acting as adsorbate entities and the surface of catalysts acting as adsorbent species. To make this mechanism more dynamic, a sufficient surface area is required for an effective photocatalysis process. As a result, examining the surface area of the developed photocatalyst material is extremely important. The inherent surface area and composed surface area may be easily compared as a result of this experiment. The surface area of doped TiO_2 is observed to be enlarged due to doping of the transition metals Fe and Ni within the crystal lattice. Table 1 shows the values for surface area, pore-volume, pore diameter, and correlation coefficient. Due to its small crystallite size and significant aggregation of nanoparticles, 5 % Fe/TiO_2 material has an enhanced surface area of 80.98 m^2/g, providing it with good porosity. The undoped TiO_2 material, on the other hand, has an intrinsic surface area of 62.25 m^2/g, while 5 % Ni/TiO_2 material has a small increased surface (63.25 m^2/g). As compared to the 5 % Ni/TiO_2, the surface area of the 5 % Fe/TiO_2 material was augmented largely, this may be due the small size of Fe^{3+} ions than Ni^{2+} ions. Overall, the

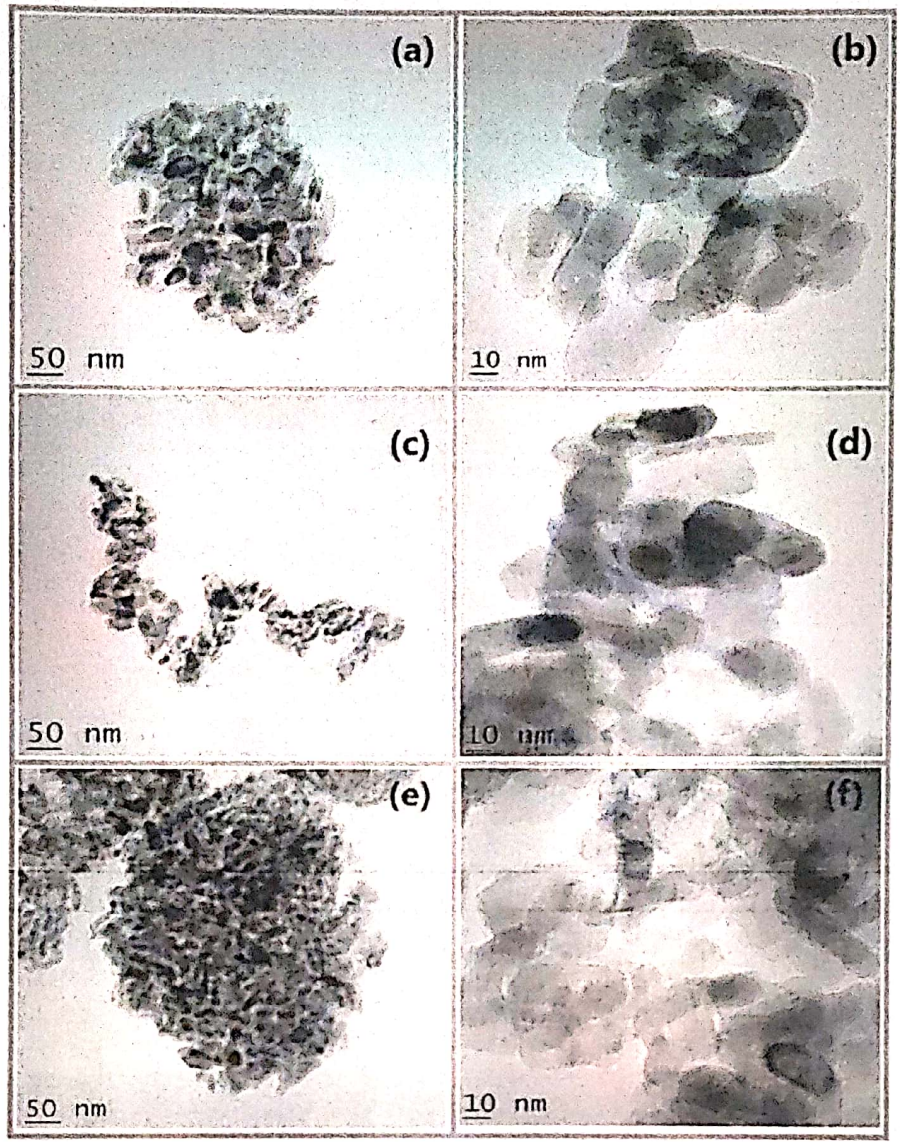

Fig. 4. (a,b) HR-TEM images of undoped TiO_2 photocatalyst, (c,d) HR-TEM images of 5% Fe/TiO_2 photocatalyst, (e,f) HR-TEM images of 5% Ni/TiO_2 photocatalyst.

Table 1
BET surface area, pore volume, and pore diameter of Undoped TiO_2, Fe^{3+} modified TiO_2 photocatalyst, Ni^{2+} modified TiO_2 photocatalyst.

Prepared Material	Surface Area (m^2/g)	Pore volume (cc/g)	Pore radius (Å)	R^2
Undoped TiO_2 photocatalyst	62.25	0.355	80.54	0.9879
5 % Ni/TiO_2 photocatalyst	63.25	0.335	79.48	0.9850
5 % Fe/TiO_2 photocatalyst	80.98	0.378	85.12	0.9989

surface area of the doped material is increased, resulting in good photocatalytic activity of the catalyst described in the fourth section. According to the current BET analysis, the adsorption bends shown in Fig. 5 a-c belong to type IV of the BDDT adsorption isotherm classes, which establishes a permeable material, out of six isotherm adsorption classifications according to the BDDT framework.

3.6. X-ray photoelectron (XPS) study

Figs. 6 and 7 show the X-ray photoelectron spectroscopy survey spectrum and individual atom binding energy curves for 5 % Fe/TiO_2 and 5 % Ni/TiO_2, respectively. The element composition, inherent features, unique binding energies, and chemical states of examined elements are represented by the XPS spectrum. The standard C-1S peak sharp at 284.20 eV is used to calibrate the spectrums. The survey spectrum shown in Fig. 6-a and 7-a represents the assembled spectrum for a specific element at specific binding energies. The titanium is the resolution at 458 eV in both images, whereas the iron is sharply resolution at 708 eV, and Ni is evident at 854 eV. The experimental data and the binding energy curves obtained in this study are in good agreement.

3.7. Parameter optimization for photocatalytic degradation of EB dye

The photocatalytic degradation of the eosine blue (EB) dye was calculated to take place at a wavelength of max 530 nm. The main degradation factors for EB dye degradation were fixed after a thorough analysis of all the parameters for undoped TiO_2, iron modified TiO_2, and

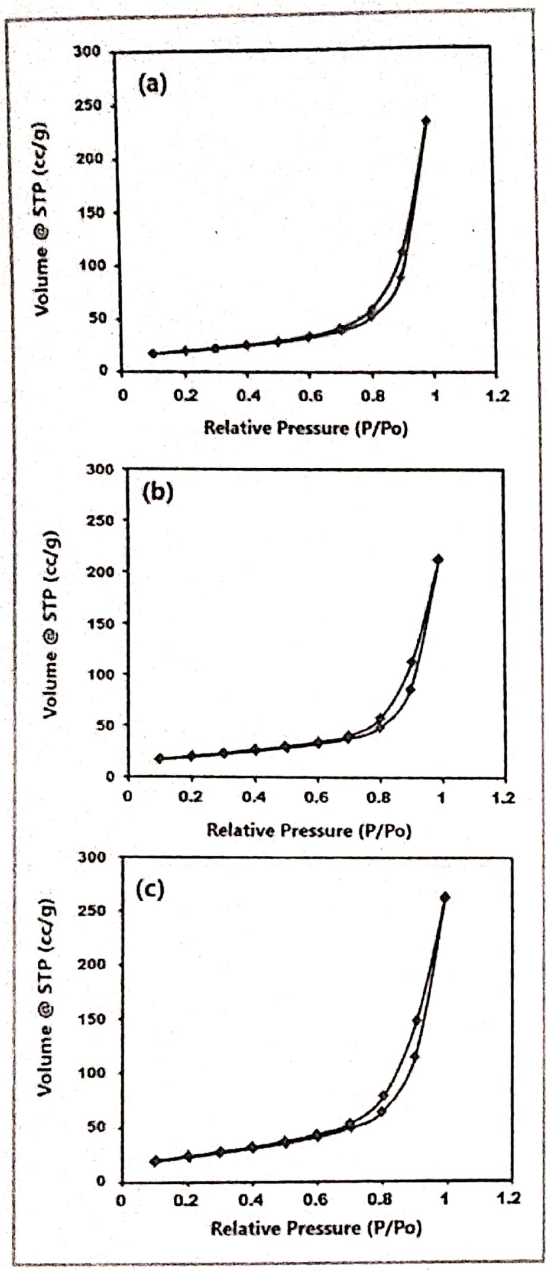

Fig. 5. BET N_2 adsorption–desorption curves for (a) undoped TiO_2 photocatalyst b) 5% Fe/TiO_2 photocatalyst, (c) 5% Ni/TiO_2 photocatalyst.

nickel modified TiO_2. The optimal dye concentration was 20 ppm, pH was 7.0, contact period was 110 min, and catalyst concentration was 0.8 g/L (for undoped TiO_2, 5 % Fe/TiO_2, and 5 % Ni/TiO_2 photocatalysts). The following parameters summarize the overall results of the photocatalytic degradation of EB dye.

3.8. Effect of catalyst dose

In catalytic-based applications, catalyst tuning is a critical parameter. The synthesized catalysts, which included undoped TiO_2, 5 % Fe/TiO_2, and 5 % Ni/TiO_2 photocatalysts, were optimized for photocatalytic degradation of EB dye at various concentrations in this study. For various catalyst doses, a batch experiment investigation was conducted. At high dye concentrations of 20 ppm to 80 ppm of EB, four batches of 0.2 g to 0.8 g catalyst doses were carried out. The gre degradation was 68.50 % to 89.52 % for 20 to ppm dye concentration the first batch of undoped TiO_2, whereas the Photocatalytic degradatio was found to be decreased with higher EB dye concentration as illustrated in Fig. 8-a for catalyst doses of 0.2 to 0.8 g. For the same EB concentration (i.e. 20 ppm) in the case of Iron modified TiO_2, increased degradation was found. For varied catalyst doses ranging from 0.2 g/L to 0.8 g/L for a 20 ppm dye concentration, the % degradation increased from 74.26 % to 96.20 %, whereas the rate of photocatalysis decreased as concentration increased, as shown in Fig. 8-b. In the case of the 5 % Ni/TiO_2 catalyst, the same pattern was seen. The degradation of dye by Ni^{2+} modified TiO_2 ranged from 70.24 to 93.26 % for 0.2 g/L to 0.8 g/L for 20 ppm EB dye concentration. As demonstrated in Fig. 8-c, the rate of photocatalysis for increased EB dye concentration was found to be lower. At EB dye degradation, the 5 % Fe/TiO_2 catalyst is found to be faster and more efficient. As the catalyst dose is increased, more active sites are created, resulting in more electron-hole pairs being generated in contact with water and ambient oxygen. For this catalyst, the decreased band gap, high surface area, and superior porosity of manufactured 5 % Fe/TiO_2 are the critical variables for optimum EB dye degradation. Because the declining band provides a convenient platform for electrons to migrate from the valence band to the conduction band, reactive species such as superoxide radicals, hydroxide radicals, and hydrogen peroxide radicals are formed when this electron is combined with water and oxygen. The main keys to the successful breakdown of EB dye, which mineralizes the EB molecules to smaller molecules, are reactive oxygen species (ROS). Because the band gap in undoped TiO_2 is larger than in Fe^{3+} modified TiO_2 and 5 % Ni/TiO_2, this efficient redox process takes longer. Fig. 8a-c depicts a collected graph depicting the influence of catalyst dose on EB dye.

3.9. Effect of change in pH over EB dye degradation

For most catalytic-based applications on the surface, the pH of the reaction is another important consideration. Because a change in pH concentration controls the majority of reactive oxygen species (ROS) and reaction equilibrium. As a result, the impact of pH on photocatalytic dye degradation is investigated in order to derive critical conclusions. Standard ZPC methods were used to evaluate the pH_{ZPC} of the synthesized catalyst TiO_2. The material's ZPC was discovered to be 7.0. Thus, below pH < pH_{ZPC}, the catalyst surface is positive, attracting negative dye species; but, above pH > pH_{ZPC}, i.e. in the basic range from 7.0 onwards, the catalyst surface is negatively charged, attracting positively charged species. Fig. 9 depicts the influence of pH concentration on the synthesized catalyst. The figure shows that up to pH = 7.0, almost 90 % of the dye is degraded. Because the catalyst's pH_{ZPC} is 7.0, it can successfully attract negative charge species up to this pH range. Because the EB dye is anionic, the catalyst surface effectively attracts the EB dye molecules, and there is successful quenching seen between dye molecules and the catalyst surface, resulting in the maximum number of EB dye molecules being attracted to this range over the catalyst surface and being rapidly degraded. Whereas with enhanced pH of more than pH = 7, the catalyst surface is now anionic in nature, and the EB dye is anionic in nature, there will be considerable repulsion between the EB dye molecules and the catalyst, and so the rate of degradation will decrease after pH 7.0, as illustrated in Fig. 9.

3.10. Effect of initial dye concentration

The concentration of EB dye was varied from 20 mg L^{-1} to 80 mg L^{-1} (20 ppm to 80 ppm) in the current study, with an optimum catalyst dose of 0.8 g fixed for all EB dye concentrations. The rate of degradation by the evaluated catalyst for EB was reduced when the concentration of EB dye was increased from 20 ppm to 80 ppm, according to the overall dye concentration analysis. With a fixed catalyst dose of 0.8 g/L, photocatalytic degradation of EB dye at concentrations of 20 ppm to 80 ppm at

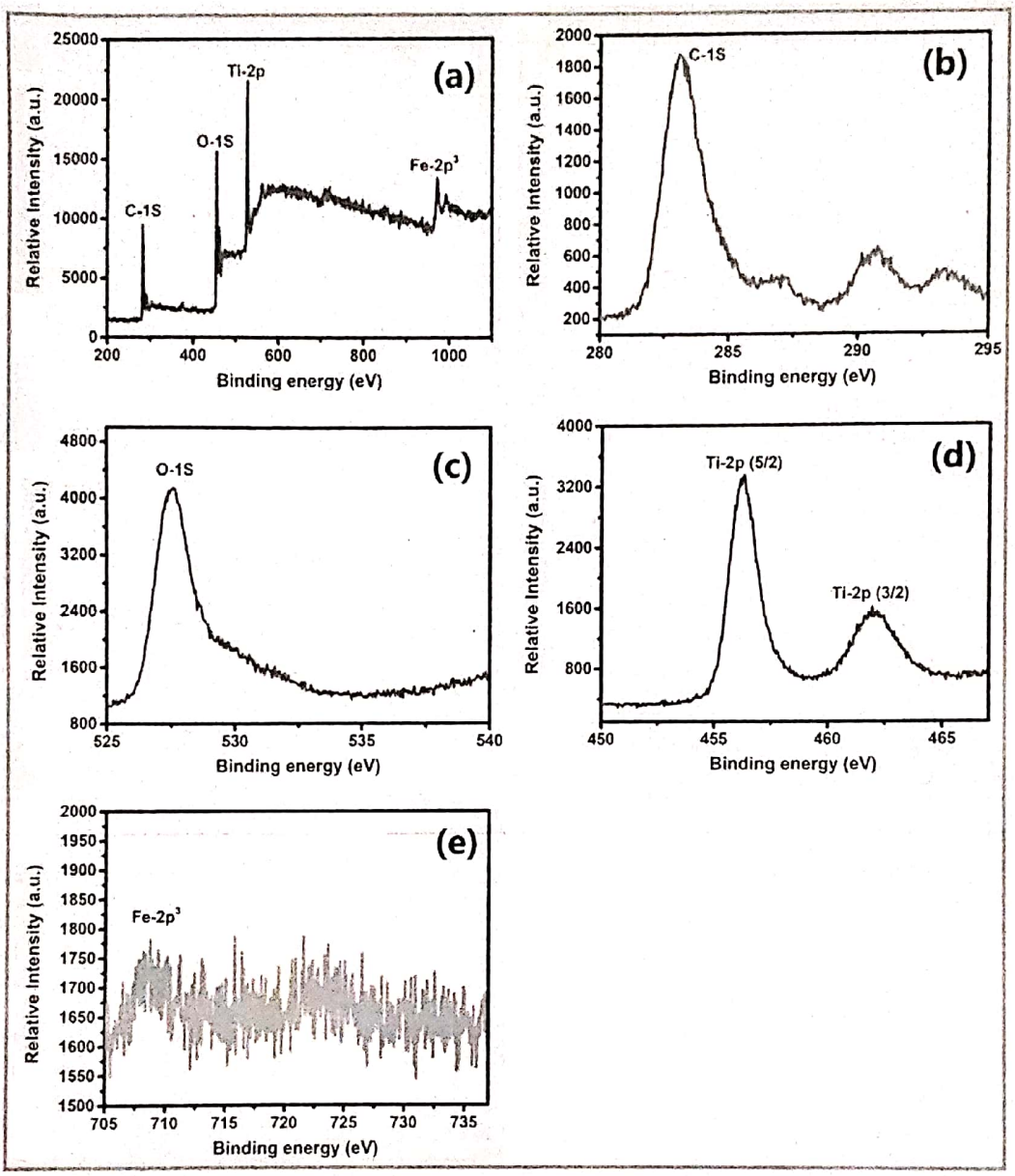

Fig. 6. (a) XPS Survey spectrum of 5% Fe/TiO_2 photocatalyst, (b) C-binding energy peak, (c) O- binding energy peak, (d) Ti- binding energy peak, (e) Fe- binding energy peak.

undoped TiO_2 was observed to be 89.20 % to 72.22 %. The rate of Photocatalytic degradation was reported to be 93.26 % to 82.25 % in the instance of 5 % Ni/TiO_2, with EB dye concentrations of 20 to 80 ppm. Photocatalytic degradation was reported to range from 96.45 % to 84.40 % in 5 % Fe/TiO_2 for EB dye concentrations of 20 to 80 ppm. As the concentration of EB dye grows, so does the accumulation of EB dye on the catalyst surface, which causes quenching between the upper energy states of EB molecules, resulting in a decrease in photocatalytic degradation of EB dye. Furthermore, due to the accumulation of dye particles on the catalyst surface, the increase in EB dye concentration prevents photons from irradiation light from coming into direct contact with the catalytic surface. The addition of more dye particles on catalyst surfaces inhibits the active sites of catalysts. With an increase in EB dye concentration, photocatalytic degradation is shown to be reduced due to the catalyst's inactivity. Fig. 10 shows a diagrammatic representation of the influence of the initial EB dye concentration.

3.11. *Effect of contact time*

The contact time assessment is a key parameter that determines the real-time necessary for photocatalytic dye degradation at various dye concentrations. Fig. 11 a-c shows the effect of contact time for various concentrations of EB dye ranging from 20 mg L^{-1} to 80 mg L^{-1}. The dye degradation is initially quite quick, with over 80 % of the EB dye being degraded in 100 min and approaching equilibrium, while the remaining 20 % of the EB dye concentration is degraded at a slower pace in the next 10 min. Because more surface-active sites of the undoped TiO_2 and doped TiO_2 catalysts are available in the first stage, the degradation of EB dye proceeds at a faster rate. These surface-active sites promote the catalyst to degrade the dye at a faster rate. As the photocatalysis process

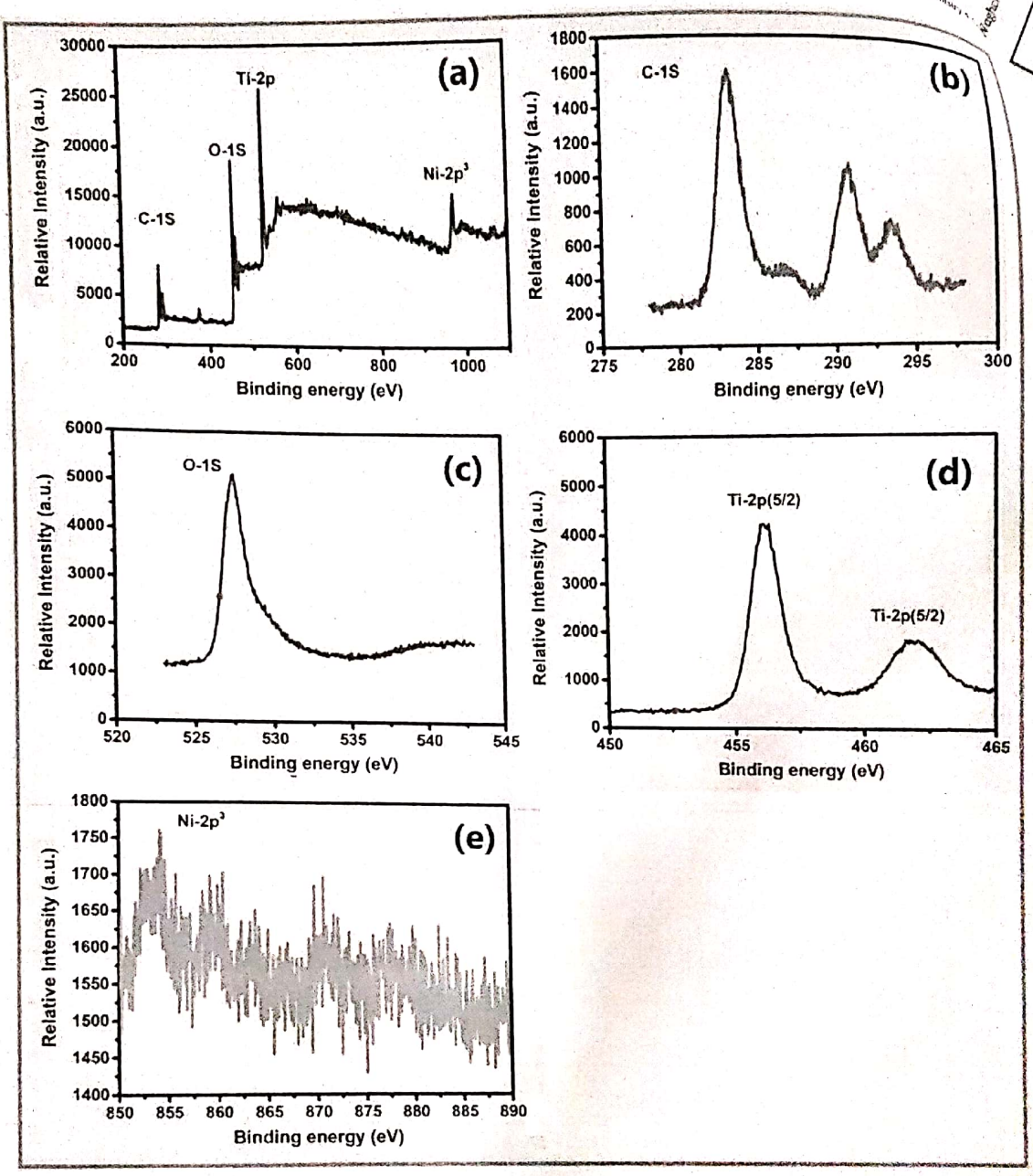

Fig. 7. (a) XPS Survey spectrum of 5% Ni/TiO_2 Photocatalyst, (b) C-binding energy peak, (c) O- binding energy peak, (d) Ti- binding energy peak, (e) Ni- binding energy peak.

progresses, dye particles or molecules accumulate on the catalyst surface, limiting the effective photon impacting the catalyst surface. With a higher concentration of EB dye, the accessible active sites and effective photon interaction diminish even more, and therefore the photocatalytic degradation of EB dye declines with increasing EB dye concentration and time. Catalyst dose of 0.8 g L^{-1}, pH = 7.0, and EB dye concentration of 20 mg L^{-1} are the parameters set for efficient degradation of the overall concentration of EB dye. The overall contact time for the reaction is found to be 110 min when all of these variables are kept constant. Complete demineralization of the EB dye happens after this contact time.

3.12. *Recyclability of photocatalyst*

Stability and reusability (green chemistry merit) are two of the traits that the ideal photocatalyst possesses. The photocatalytic degradation of eosine blue dye by the UV light source corroborated these capabilities of undoped and doped TiO_2. To assure the catalyst's reusability, the solution was allowed to settle by gravity shortly after photocatalytic deterioration, and then the powdered nanocatalyst was separated. The separated nanoparticles were calcined in a muffle furnace and then reused three times under the same photocatalytic preparation conditions. Degradation of EB dye using pure titanium oxide was recorded for successive four runs and which found to be 91 % after the first run, 88 % after the second run, 83 % after the third run, and 79 % after the fourth run, respectively, while degradation of EB dye using 5 % Fe/TiO_2 was

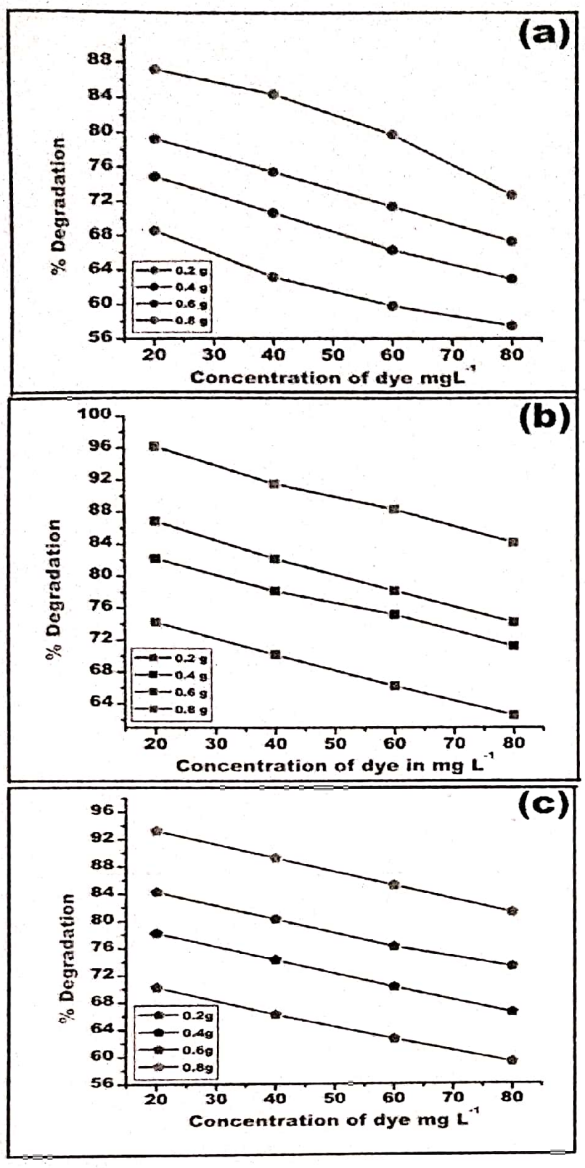

Fig. 8. 0 (a) Effect of TiO_2 catalyst dose on % degradation of EB dye for different EB dye concentrations, (b) Effect of Fe^{3+} doped TiO_2 catalyst dose on % degradation of EB dye for different EB dye concentrations, (c) Effect of 5 % Ni/TiO_2 catalyst dose on % degradation of EB dye for different EB dye concentrations.

found to be 96 % after the first run, 95 % after the second run, 92 % after the third run, and 85 % after the fourth run, as shown in Fig. 12. In this method, pure and doped titanium oxide nanocatalysts are found to have superior stability and crystanality. The investigation found that due of the reusability of the nanocatalysts, the degree of degradation of the EB dye decreased with each catalyst recycled. The fact that both pure and doped titanium oxide nanoparticles do not photoerode during UV light-induced deterioration is surprising (see Fig. 13).

3.13. Comparison of the prepared catalyst

TiO_2-based nanomaterials and nanocomposites are employed for photo-induced degradation of various dyes, thiazo dyes, azo dyes, herbicides, color matrix, and effluent from fast-growing pharmaceutical sectors, chemical waste, and industrial effluents. The comparison is

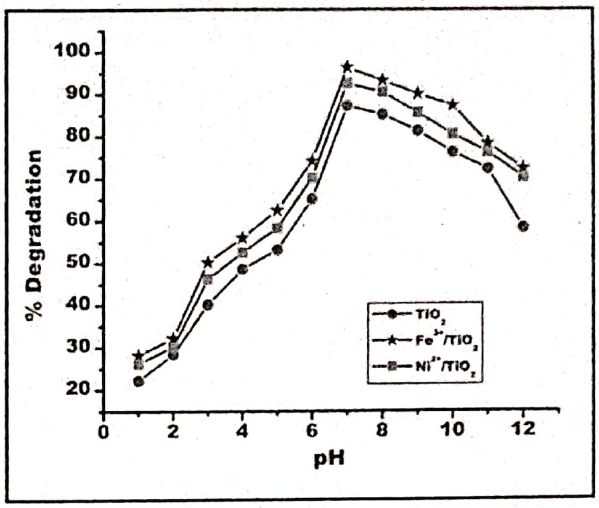

Fig. 9. Effect of pH on degradation of EB dye for undoped TiO_2, 5% Fe/TiO_2 and 5% Ni/TiO_2

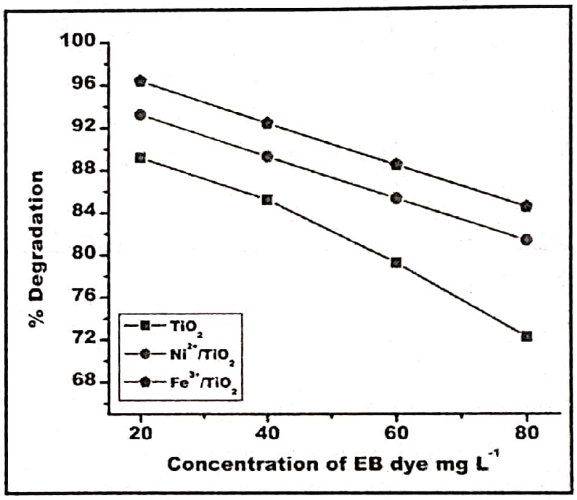

Fig. 10. Effect of initial dye concentration for degradation EB dye for undoped TiO_2, 5 % Ni/TiO_2 and 5 % Fe/TiO_2 at pH = 7.0 and 0.8 gL^{-1} catalyst.

based on similar types of TiO_2-based nanomaterials utilized as photocatalysis for photoinduced degradation of various organic contaminants and colors reported in the literature. For the degradation of EB dye, the developed modified catalyst was used as a photocatalyst. In a 20 ppm dye concentration in a slightly alkaline environment with a contact period of 110 min and a catalyst dose of 0.8 g/L, the results are extremely efficient and significant for the degradation of EB dye. The comparative study among the present photocatalyst and reported ZnO-based materials for photocatalytic degradation of various dyes is represented in Table 2.

3.14. Photocatalytic reaction mechanism

Fig. 14 illustrates the possible photocatalytic reaction pathway of EB dye applying 5 % Fe/TiO_2. The three main species involved in the photocatalytic degradation of the EB dye solution are hydroxyl radicals, photogenerated holes, and superoxide radical anions [65–67]. Major factors in the photocatalytic degradation of organic dyes include hydroxyl radicals and photogenerated holes. Under visible light, the same amounts of holes (h^+) are discharged in the valence band while the

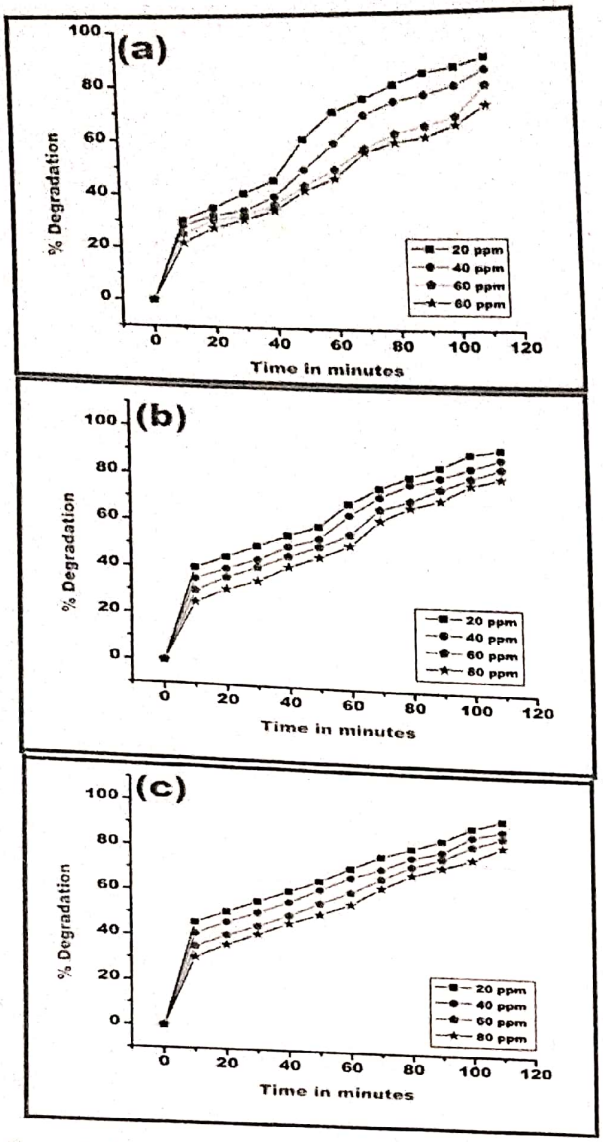

Fig. 11. (a) Contact time study for EB dye degradation at undoped TiO_2, (b) Contact time study for EB dye degradation at 5 % Ni/TiO_2, (c) Contact time study for EB dye degradation at 5 % Fe/TiO_2 at pH = 7.0, catalyst dose 0.8 g/L.

electrons in the valence band are stimulated to shift to the conduction band. Dissolved oxygen (O_2) combines with electrons in an aqueous solution to create active free radicals like OH, O_2, and so on. With the help of electron donors (H_2O), the separated holes will react to create active OH free radicals. The resultant h^+ and other free radicals, including OH, O_2, and others, then attacked the surface-adsorbed EB molecules, causing decolorization and opening-ring processes.

4. Conclusions

The low-cost and efficient CPT technique was used to synthesize TiO_2, 5 % Fe/TiO_2, and 5 % Ni/TiO_2 nanomaterials. The modern analytical techniques like XRD, SEM-EDS, HR-TEM, XPS, and BET analyses were performed to explore structural, morphological and elemental analysis of the synthesized nanomaterials. The analytical investigation confirmed the anatase phase with tetragonal crystal lattice of TiO_2 and augmented surface area for 5 % Fe/TiO_2. All three photocatalysts were utilized for the UV light-driven degradation of the EB Dye.

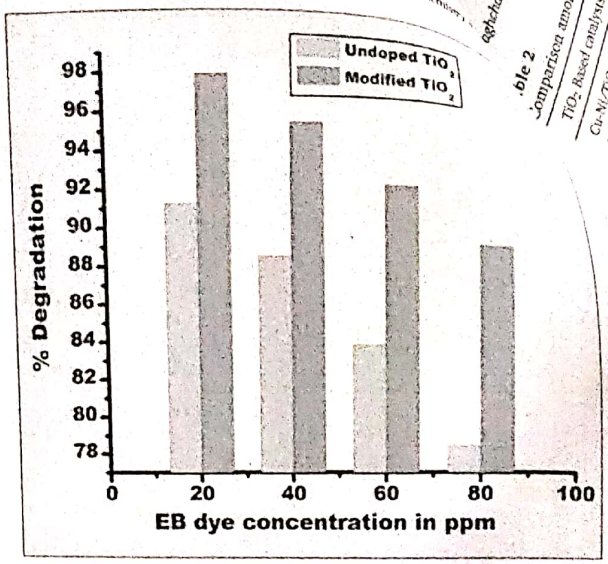

Fig. 12. Effect of initial dye concentration on % degradation of EB dye for undoped TiO_2 and 5 % Fe/TiO_2 at catalyst dose 0.8 g, pH 7.0.

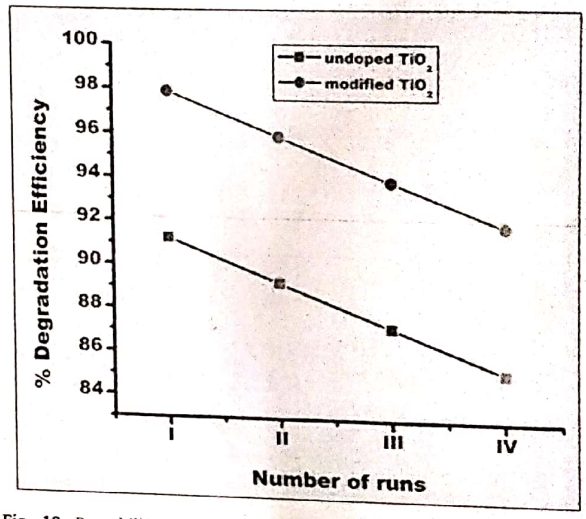

Fig. 13. Reusability tests for prepared TiO_2 and 5% Fe/TiO_2 catalysts at EB dye.

The 5 % Fe/TiO_2 photocatalyst was found to be more efficient in the destruction and decolorization of the EB dye at optimized parameters which is attributed to its enhanced surface area. At the optimized parameters; catalyst dose = 0.8 g/L, pH = 7, and initial dye concentration = 20 mg/L, the 5 % Fe/TiO_2 was exhibited potent degradation ability with 96.45 % photodegradation of the EB dye in just a 110 min. Moreover, the reusability of the photocatalyst was tested by performing the four cycles of the experiment and which revealed that there was a small declined in the photocatalytic activity of the catalyst and highlights the reusability and stability of the photocatalyst.

CRediT authorship contribution statement

Ravindra Haribhau Waghchaure: Conceptualization, Methodology, Software, Data curation, Writing – original draft, Writing – review & editing. **Prashant Bhimrao Koli:** Conceptualization, Methodology, Software, Data curation, Writing – original draft, Writing – review & editing. **Vishnu Ashok Adole:** Conceptualization, Methodology,

Table 2
Comparison among 5% Fe/TiO_2 catalyst and reported TiO_2 based materials for photocatalytic degradation of different dyes.

TiO_2 Based catalysts	Method of preparation	% D	Irradiation Under	Dye	Irradiation time (min.)	Year	Ref.
Cu-Ni/TiO_2	Hydrothermal	97.0	Visible light	Rhodamine B	90	2021	[58]
Nanosized TiO_2	Commertialy available	90	UV light	Metylene blue	60	2016	[59]
GO/TiO_2	Hydrothermal	90	UV light	Methylene Orange	240	2020	[60]
Ag-MoO_3-TiO_2	Sol-gel method	97	Solar light	Methyl orange	300	2018	[61]
Polymer modified-TiO_2	Co-precipitation	93	Solar light	Methylene blue	90	2017	[62]
TiO_2-Fe_2O_3 nanocomposite	Sol-gel	79.1	UV light	Methylene blue	60	2020	[63]
B-GO-TiO_2	Co-precipitation method	100	Visible light	4-NitroPhenol	180	2016	[64]
TiO_2–CNT heterostructures	hydrothermal	100	Visible light	RhB	80	2015	[65]
5 % Fe/TiO_2	Co-precipitation	96.70	UV	Eosine blue	110	Present Research	

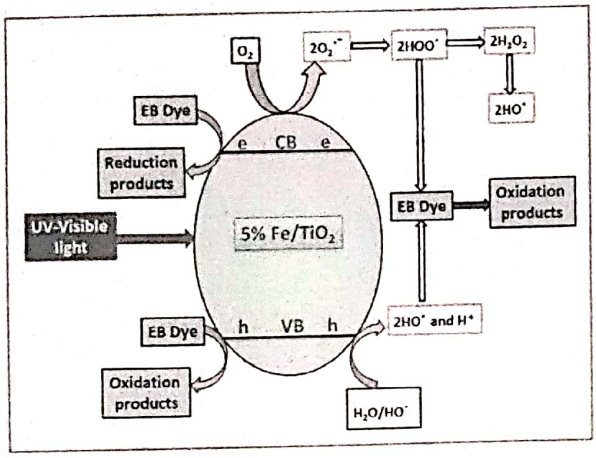

Fig. 14. Photocatalytic reaction mechanism.

Software, Data curation, Writing – original draft, Writing – review & editing. **Bapu Sonu Jagdale:** Supervision, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Visible light prompted and modified ZnO catalyzed rapid and efficient removal of hazardous crystal violet dye from aqueous solution: A systematic experimental study

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ABSTRACT

Zinc oxide, iron-doped zinc oxide, and nickel-doped zinc oxide were tailored by the economic co-precipitation method. The hexagonal structure of the prepared samples was affirmed by structural investigation. The optical investigation confirmed that doping of Ni and Fe metal ions tune the band gap to 2.96 eV and 2.93 eV, respectively from 2.99 eV. The porous and voids across the surface of the photocatalyst were confirmed by SEM analysis and the elemental composition was validated by EDS. The 3.5 % Fe/ZnO was found superior photocatalyst to decolorize the cationic Crystal violot (CV) dye due to its small band gap and porous surface of the catalyst. It degraded almost 99.88 % CV dye within 60 min only, which was faster than 3.5 % Ni/ZnO (95 min) and ZnO (120 min). The competitive adsorption effect by strong ionic effect shown by anions can define the role of reactive species such as hydroxyl radicals, and superoxide anions in presence of CV dye.

1. Introduction

Industrial textile waste has high concentrations of organic contaminants, especially coloring agents [1–4]. There is a significant risk to the environment from the release of this industrial waste into water sources without first being purified. Azo dyes are the primary class of dyes that may be utilized in the global textile industries and are in charge of producing color [5–7].

According to the literature review, the world's textile manufacturers discard between 15 % and 20 % of all dyes, which are then discharged into water resources [8–11]. Even at extremely low levels, these dyes are visible in water and significantly degrade water quality. Additionally, they have a negative effect on the environment by decreasing the amount of light that is available underwater, which directly affects the process of biological processes [12–15]. Additionally, because they contain dyes, the turbidity of the water is increased, which lowers the amount of dissolved oxygen that is available and affects the aquatic ecosystem. Numerous of these dyes are difficult for biological processes to break down, which keeps them in the water for a longer period and endangers both mankind and the environment's flora and fauna [16–19]. To remove organic pollutants and help clean the environment, this wastewater is targeted before it is discharged into water sources [20–23].

Adsorption, coagulation, chlorination, flocculation, and filtering are classified as old physical and chemical processes that are less effective at eliminating organic contaminants to simple minerals [24–27]. These contaminants have the capacity to produce metal complexes, which can result in a number of issues and take time, and become less practical [28–30].

Researchers have recently been more interested in advanced oxidation processes (AOP), particularly photocatalytic processes, which have great potential, are cost-effective, and are important in the wastewater

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treatment process. The efficacy of these methods depends on the generation of reactive species, primarily hydroxyl radicals (•OH), which play a role in transforming organic contaminants by causing them to degrade into simple minerals (H_2O and CO_2) [31–35] Fig. 1.

After exposure, the reaction is started on the surface of the semiconductor photocatalysts as such ZrO_2, TiO_2, and ZnO, etc. by UV/visible light. Electronic excitement from the valance band is transferred via reaction to the higher energy conduction band to create electron-hole pairs [36–39]. The redox reaction is aided by these electron-hole pairs, which also contribute to the oxidation of the organic pollutant by producing more energetic hydroxyl radicals. The selection of the photocatalyst, which determines its capacity to generate electron-hole pairs and, ultimately, hydroxyl radicals, as well as its ability to absorb light, is a key factor in how the process turns out [40–43]. Due to the Optical features, lower risk, good electrical properties, and an easy-to-use, cost-effective synthesis methods, recently, ZnO semiconducting materials have attracted a lot of attention since they have proven to be effective and significant nanomaterials that are widely utilized to degrade dyes in the most practical manner. The wide band gap (3.37 eV) and greater recombination rate of hole-electron pairs are some of its drawbacks [44–48].

There is great need to develop techniques that address the aforementioned shortcomings in order to dope ZnO nanoparticles with metal and metal oxide nanoparticles in varying percentages for better performance and potential use as a photocatalyst. ZnO nanoparticles stand out in this context, particularly when transition metal ion doped (Ni, Fe, Ag, Cu, etc.) as an effective and substantial photocatalyst to degrade organic and hazardous pollutants [49–53]. ZnO doped with various transition metal ions can change the band gap, which lowers the recombination rate of the active species, namely electron-hole pairs, and ultimately results in a notable improvement in the doped catalyst's efficiency over undoped ZnO [54–58]. Accordingly, the co-precipitation method was used to create a Ni/ZnO, Fe/ZnO photocatalyst with varying concentrations of dopant Ni and Fe metal ions, with 3.5 % Fe/ZnO emerging as a potential catalyst for the degradation of the CV dye in comparison to the other nanomaterial. With a pH, contact time, catalyst dose, and other factors optimized, the concentration of Fe as a dopant was determined to be 3.5 %, which was found to be moderate to change the characteristics of ZnO suited for the effective breakdown of the organic pollutant.

The investigation reported displayed the potential of 3.5 % Fe/ZnO as an efficient photocatalyst in the deterioration of CV dye almost 99.88 % in a short time of 60 min than bare ZnO and its nickel-doped catalyst. Furthermore, its stability and reusability were confirmed by repeating the successive use of the catalyst for up to 4 cycles. The involvement of reactive species was traced by electrolytic experiments and analytical techniques like SEM, XRD, UV–Visible, and EDS to validate the tailoring of photocatalysts. The present investigation might be proven as a significant step towards future research in the field of photocatalysis.

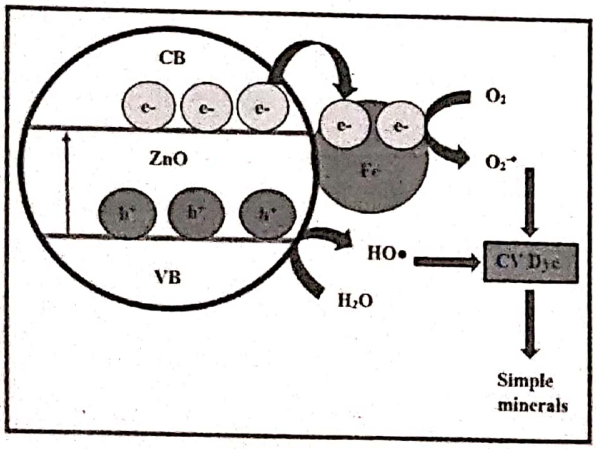

Fig. 1. Photodegradation mechanism of CV dye.

2. Materials and methods

Zinc nitrate, iron nitrate, nickel nitrate, NaOH, and CV dye, were all chemicals that were acquired from the commercial lab and used without further purification. Deionized water was used to make a stock solution of the dye at a concentration of 100 mg/L. Later on, deionized water from the prior stock solution was used to make all experimental solutions in the concentration range of 5, 10, and 15 mg/L.

2.1. Preparation of pristine ZnO nanoparticles by co-precipitation method (CPT method)

The precursor ($Zn(NO_3)_2{\cdot}6H_2O$) and NaOH were used to create ZnO NPs utilizing a cost-effective co-precipitation process. During synthesis, 0.02 M of zinc nitrate was added to a beaker of deionized water and stirred continuously for 40 min at room temperature. Add 0.02 M NaOH drop wise to this solution over the course of the next 30 min while stirring constantly with a magnetic stirrer set to 85 °C. At this point, the solution turns turbid and reaches a pH of 12. Keep the heat on for the next four hours. Furthermore, this solution was centrifuged for 20 min after being exposed to ultrasonic for 20 min, and after being thoroughly cleaned with solvent ethanol and deionized water; the white product of ZnO was isolated. The isolated product was dried in an oven at 100 °C for an entire night, ground into a fine powder with a mortar and pestle, and then calcined in a muffle furnace at 550 °C for four hours.

2.2. Tailoring of Fe^{3+} doped ZnO and Ni^{2+} doped ZnO nanoparticles by co-precipitation method

For the synthesis of iron and nickel doped modified ZnO nanoparticles, the same method as explained in Section 2.1 was followed. But, additionally, 3.5 % iron (III) nitrate nonahydrate as a dopant precursor was added to the solution of zinc nitrate to prepare Fe^{3+} doped ZnO (Fe/ZnO). The nickel(II) nitrate hexahydrate as a dopant precursor was added to the solution of zinc nitrate to prepare Ni^{2+} doped ZnO (Ni/ZnO).

3. Results and discussion

3.1. UV–Visible absorption studies

It is significant to record the UV–Visible spectrum of the tailored nanomaterial because from this we calculate the band energy of the corresponding nanomaterial to support the formation of nanomaterial. The UV–Visible spectrum of bare ZnO, Ni/ZnO, and Fe/ZnO was recorded from which red shift indicated the accomplished of surface modification. Fig. 2 **a)** revealed the combined absorption spectra of bare ZnO, and modified ZnO, whereas Fig. 2 **b)** revealed the combined Tauc plot of the ZnO and modified ZnO. From the observation of the absorption spectra and Tauc plot, it was revealed that the Fe/ZnO, and Ni/ZnO display the red shift and their band gap value was found to be 2.99 eV of ZnO, 2.96 eV of Ni/ZnO, and, 2.93 eV of Fe/ZnO. This band gap energy decides the degree of photoexcitation of the electrons, by considering the same nanomaterial with a lower band gap leads to maximum photoexcitation of electron and contribute to enhanced photocatalytic activity and vice-versa for nanomaterial with a higher band gap. From band gap energy value, it validated the superior catalytic activity of Fe/ZnO over Ni/ZnO and ZnO.

3.2. X-ray diffraction (XRD)

In a muffle furnace, the bare ZnO, Ni/ZnO, and Fe/ZnO were

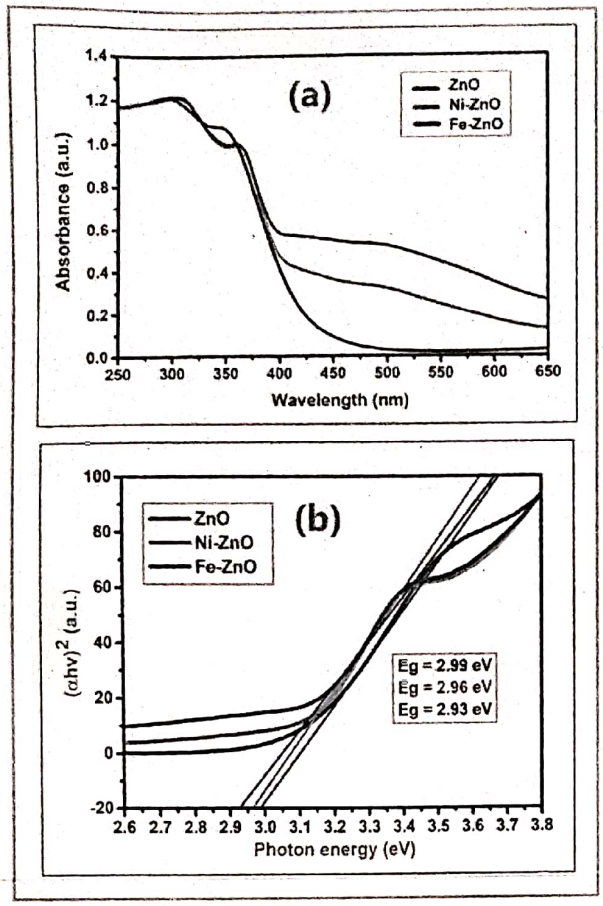

Fig. 2. (a) Combine UV/visible absorption spectra (b) combine optical band gap of bare Zno, Ni/Zno, and Fe/Zno photocatalyst.

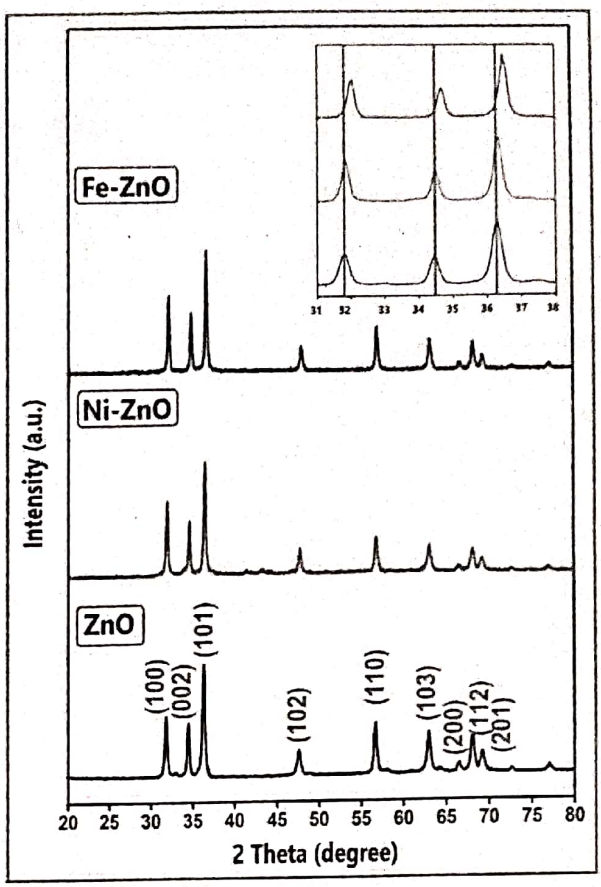

Fig. 3. Combine XRD pattern of bare ZnO, Fe^{3+}/ZnO photocatalyst, Ni^{2+}/ZnO photocatalyst.

calcined and confirmed by XRD using the model D8 advance from Bruker AXS GmbH. (Germany). The results from Fig. 3 showed that the material is in the crystalline phase, and the Braggs reflection peaks confirmed the existence of a hexagonal ZnO crystal lattice. Assigned diffraction peaks are 32.0, 34.66, 36.48, 47.74, 56.82, 63.06, 66.50, 68.18, 69.24, and 77.10 to the reflection planes (100), (002), (101), (102), (110), (103), (200), (112), (201), (202) planes. The absence of any signs of the other component in the spectrum confirmed the material's purity. The 2 Theta values of the Ni/ZnO and Fe/ZnO diffraction peaks are almost identical to those of pure ZnO. The 2 Theta value is significantly changed by the moderate dopant concentration, then sift in the 2-Theta value is due to the successful incorporation of the iron ion into the lattice of the ZnO seen from the XRD. The formation of the ZnO nanomaterial is aided by the aforementioned diffraction patterns. The average particle size is an important property and can be calculated by using Debye-Scherer's formula [$D = K\lambda/\beta \cos\theta$] in which D is the average particle size, K is constant (0.9 to 1), β is FWHM of the diffracted peak, θ is the angle of diffraction. The calculated average particle size for ZnO, Ni/ZnO, and Fe/ZnO are 26 nm, 22 nm, and 20 nm respectively.

3.3. High resolution Scanning Electron Microscopy: (HR-SEM)

The surface, surface morphology, and voids/pores of the produced nanoparticles are all extensively described in the SEM (Scanning Electron Microscopy) photos. Fig. 4 **a to b** show SEM images of pure ZnO, **c to d** show SEM images of Ni/ZnO, and **e to f** show SEM images of Fe/ZnO. The outcome demonstrates the hexagonal crystal structure of the ZnO, and some voids have developed all over the surface. While the Ni/ZnO surface morphology shows hexagonal-shaped nanoparticles with a distinct size. Fe/ZnO is a promising nanomaterial for catalytic performance because of the shape of the material, which exhibits cavities or pores over the surface.

3.4. Energy dispersive spectroscopy (EDS)

EDS technique gives full information about the elemental composition that is present in the designed nanoparticles. The elemental composition of the designed nanoparticles is in agreement with the reference shown in Fig. 5 **(a-c)**. The element zinc scales up on the peak at 8.5 KeV, while oxygen scale-up at 1.0KeV, and Nickel at 7.5KeV, Fe appeared at 8.5KeV. All information regarding series, elemental composition, and atomic wt % are tabulated on the EDS spectrum as shown in Fig. 5 **(a-c)**.

3.5. Photocatalysis study of Crystal violet (CV) dye for modified ZnO catalysts

Deterioration of the Crystal violet CV) dye induced by UV/visible light to affirm the potential of tailored ZnO, and transition metal ion (Ni, Fe) incorporated ZnO photocatalyst. The early stage of the experiment involves the observations of which first the solution consists of a photocatalyst of 0.05 g in a 100 ml 5 ppm solution of the CV dye. Afterword's second observation was recorded in the dark, and lastly, the CV dye solution was under UV light but in absence of the catalyst. The latter experiment was performed from t = 0, and catalyst dose in the 0.1 to 0.7

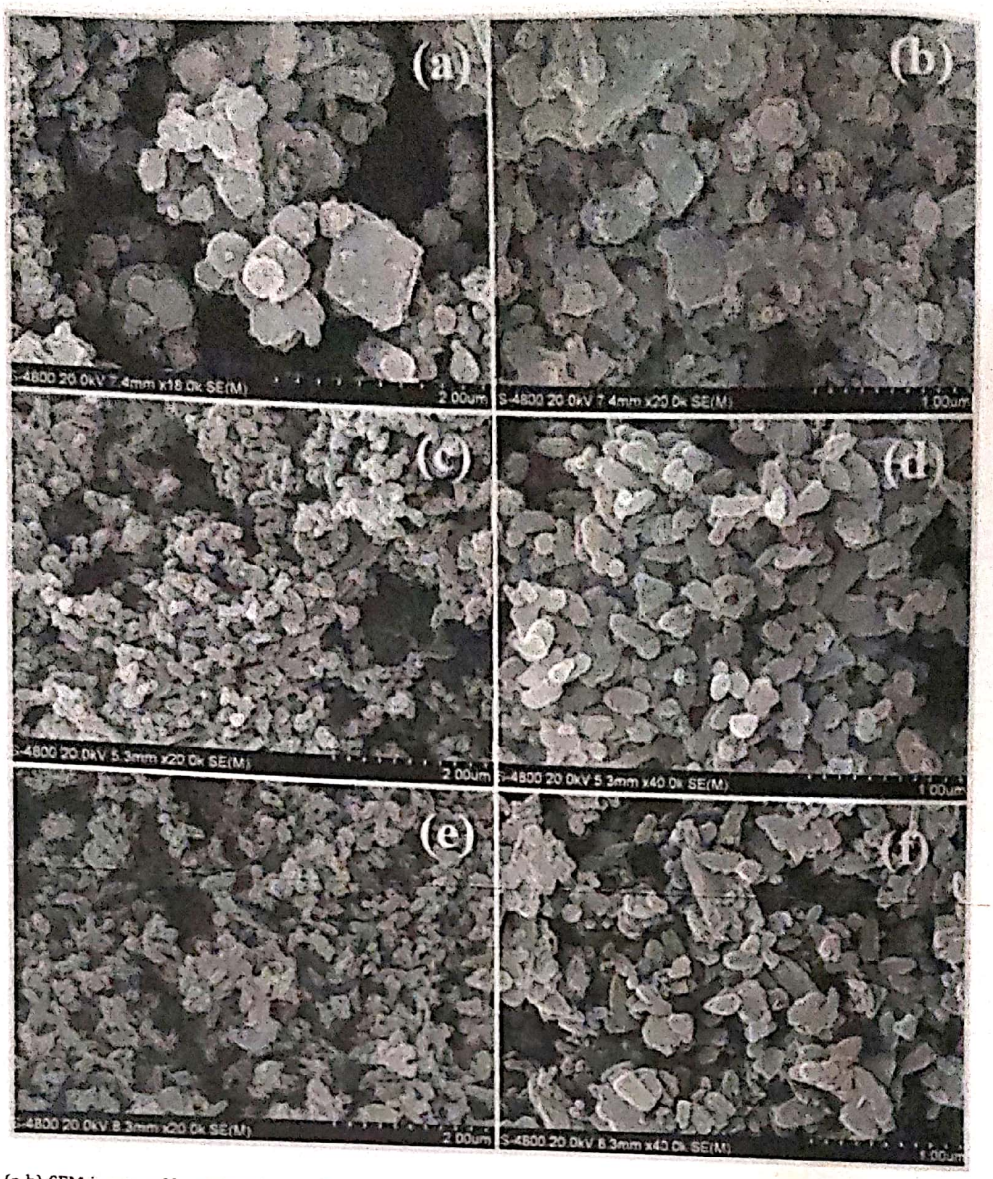

Fig. 4. (a,b) SEM images of bare ZnO photocatalyst (c,d) SEM images of Ni/ZnO photocatalyst, (e,f) SEM images of Fe/ZnO photocatalyst.

g/L and dye concentration in the range 5 mg/L to 15 mg/L, reading was taken after 5 min intervals and measurement was done with double beam spectrophotometer (UV–Visible) at an absorbance wavelength of CV dye λ^{max} 590 nm. % degradation of dye evaluated with the help of the Eq. (1)

$$\% \text{ Degradation} = [(C_0 - C_t)/C_0 \times 100] \quad (1)$$

3.6. Photocatalytic degradation study of the tailored nanoparticles

Over cationic CV dye, the effectiveness of customized catalysts ZnO, Ni/ZnO, and Fe/ZnO were evaluated. Using a double-beam spectrophotometer to record absorbance at 5-min intervals, the rate of degradation of CV dye was measured. Cationic dye at 5 ppm and specially formulated photocatalyst added. The initial experiment is depicted in Fig. 6, which shows that the absorbance of CV dye at a concentration of 5 mg/L is unaffected by visible light in the absence of a catalyst. On the absorbance of cationic CV dye, there has been a minimal influence both in the presence of a catalyst and in the absence of light. The third observation was also made using photocatalysts made of ZnO, Fe/ZnO, and Ni/ZnO (0.5 g/L) in the presence of UV/visible light and CV dye at a concentration of 5 ppm. In nutshell tailored nanoparticles display superior catalytic activity to destruct the cationic CV dye.

3.7. Effect of initial dye concentration

To confirm the effectiveness of customized nanoparticles ZnO, ZnO, Fe/ZnO, and Ni/ZnO in the degradation of dye as shown in Fig. 7 **a–c** Cationic CV dye was considered an organic contaminant in this context. A sample of CV dye with an initial concentration of between 5 and 15 mg/L was taken to assess the superiority of the three photocatalysts listed above. In comparison to 3.5 % Ni/ZnO, which requires 95 min, and bare ZnO, which requires 120 min for complete decolorization, Fe/ZnO acts as a superior catalyst under UV light irradiation for a specific period of time, degrading roughly 99.88 % of 5 ppm CV dye concentration in just 60 min. This might be due to the incorporation of metal ions into host ZnO could tune the band gap, and enhance the optical, and structural properties of the resulting photocatalyst, which was more into

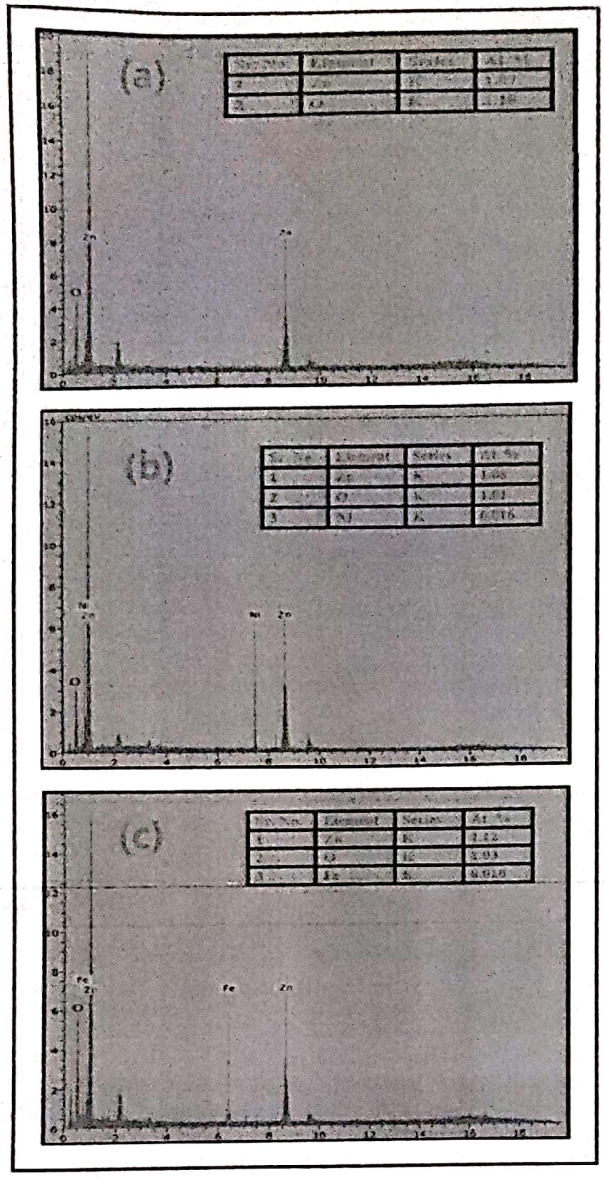

Fig. 5. (a) EDS spectrum of bare ZnO photocatalyst, (b) EDS spectrum of Ni/ZnO photocatalyst, (c) EDS spectrum of Fe/ZnO.

Fe/ZnO. It was notable that as the dye concentration raise further shifted the degradation to lower might due to less availability of $OH^{\bullet}$ and lower interaction of the surface of the catalyst wrap with the dye molecule and photon of light.

3.8. Effect of catalyst dose

This parameter depicted in Fig. 8 **a-c** is crucial to decide the exact amount of catalyst loading for the complete mineralization of the CV dye under optimized conditions. This testing was done in the range of 0.1 g to 0.7 g under UV light irradiation and it was clear that a very small amount of 0.5 g photocatalyst was required for the mineralization of 5 mg/L CV dye concentration. Such an amount can highlight the efficiency as well as the economy and green nature of the photocatalyst. Further, it was seen from the experiment that an increase in catalyst loading increases the percentage of deterioration up to a certain point, which then falls down due to the scattering of photons from the surface of the catalyst.

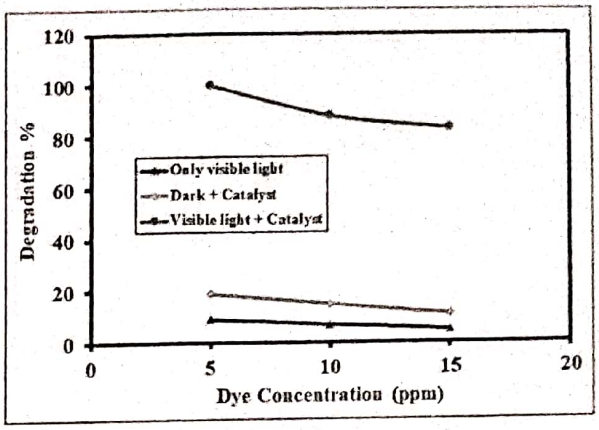

Fig. 6. Effect of light irradiation and catalyst on dye degradation.

3.9. Electrolyte experiment

A crucial effect of the anions on the destruction of the organic pollutant has been discussed due to their presence and interference by competitive adsorption. These inorganic anions such as carbonates, chlorides, phosphates, and sulfate present in water and wastewater are found to be basic. Fig. 9 displayed the comparison of the anionic effect of having a concentration of 0.05 M over the absence of an anion test in CV aqueous solutions, anions interfere and lower the percentage degradation at a certain point. These anions strongly interfere with the deterioration of CV dye by stronger adsorption over the surface of the photocatalyst than the CV dye molecule, because anions have stronger ionic strength and the ability to trap positively holes and reactive hydroxyl radical to reduce their percentage on the photocatalyst surface and thereby reduce percentage degradation of CV dye. The HCO_3^- belongs to the divalent charge and displays higher ionic strength than single valance ions such as Cl and PO_4^{3-} and shows higher competing adsorption. Furthermore, the presence of NO_3^- reflects a lower effect on the degradation of the CV dye when UV light is turned on. In a nutshell, the overall inhibition effect is validated by the formation of less reactive radicals in connection with competitive adsorption during the course of the degradation experiment.

3.10. Reusability of photocatalyst

To meet green outcomes for environmental safety and reduced chemical waste the produced nanoparticles must have stability and reproducibility, which lowers the time and enhances the economy. The efficient Fe/ZnO for the deterioration of the cationic CV dye was further tested for stability and its reproducible nature. The photocatalytic experiment was assessed for the four successive run and their efficiency was assessed. After completion of the experiment, the solution was kept for a certain time to settle the photocatalyst, then the liquor was removed and the rest compound was centrifuged the isolated product was subjected to drying and then calcined at temperature and reused for the experiment. From the graph, it was clear that the Fe/ZnO catalyst bears good stability and has reproducible properties. The catalyst showed superior nature in the discoloration of CV dye and its activity remained almost the same after each successive run of the experiment (Fig. 10).

3.11. Comparison of the prepared catalyst

The variety of dyes (azo, thiazo, color matrix, etc.) is get photodisintegrated by many semiconducting nanomaterials out of which ZnO and ZnO-supported, doped nanomaterials are widely used in this regard. The comparison of the present reported photocatalyst ZnO, Ni/ZnO, and

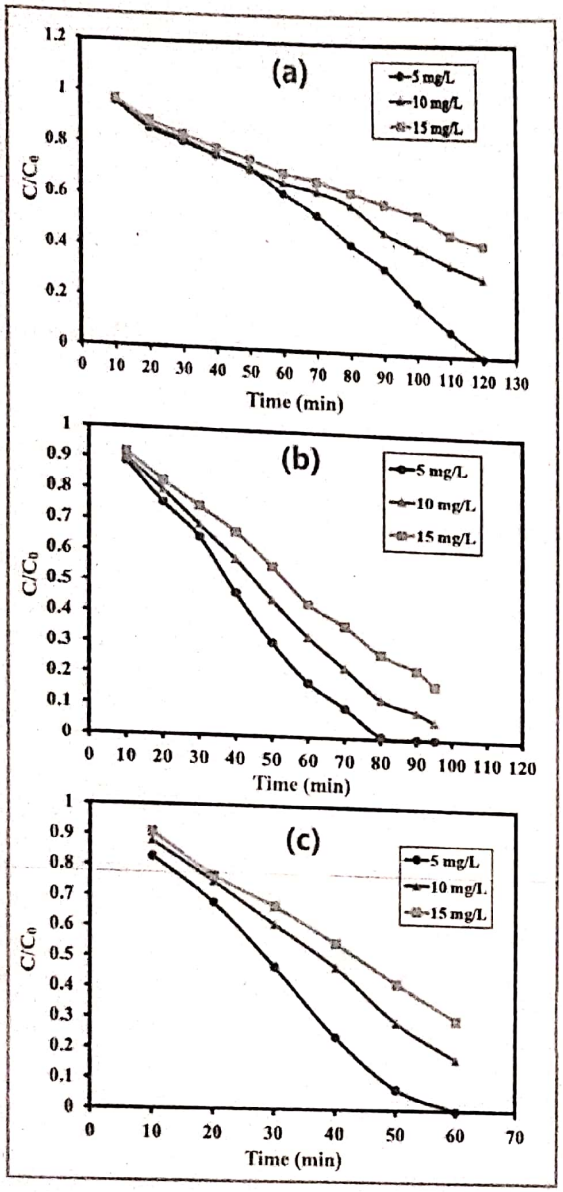

Fig. 7. Effect of initial dye concentration for degradation CV dye (a) for bare ZnO, (b) Ni/ZnO, (c) and Fe/ZnO.

Fe/ZnO with other ZnO-based nanomaterials from literate are done to know about the significance of the present photocatalyst. The tailored nanomaterial especially Fe/ZnO was used for the photodisintegration of Crystal violet dye (CV) and found to be efficient, it degrades almost 99.88 % CV dye in just 60 min. The potential of ZnO-based material over the degradation of different dyes compared with Fe/ZnO catalyst against CV dye is tabulated in Table 1.

4. Conclusions

Successfully tailoring the Fe/ZnO, and Ni/ZnO by economic co-precipitation method, their potential applicability for the deterioration of cationic CV dye was performed under UV/Visible light. The tuning of band gaps and the crystalline nature of photocatalysts make them better and more stable photocatalysts especially Fe/ZnO which was quite superior due to the small band gap energy confirmed by UV–Visible spectra. Furthermore, their stability and performance were validated by a reusability experiment, which affirmed that after four successive runs efficiency remain nearly the same which highlights the potential nature of Fe/ZnO as a photocatalyst in the removal of organic pollutant and keeping the environment safe. Additionally, a trace amount (0.5 g/L) of Fe/ZnO catalyst is sufficient to deteriorate the organic dyes effectively, in this case, 0.5 g of Fe/ZnO could degrade nearly 99.88 % cationic CV dye. This catalyst might be an effective photocatalyst in the removal of

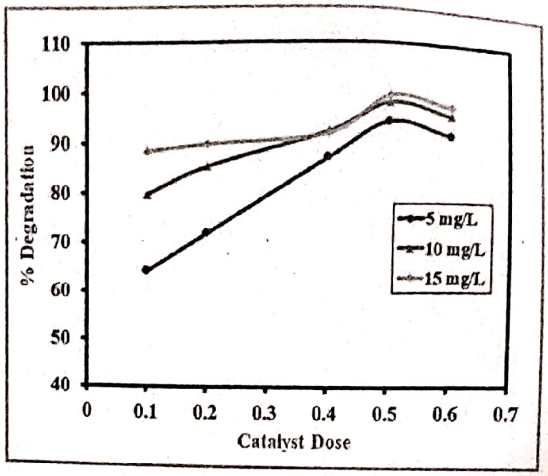

Fig. 8. Effect of catalyst dose on the degradation of CV dye.

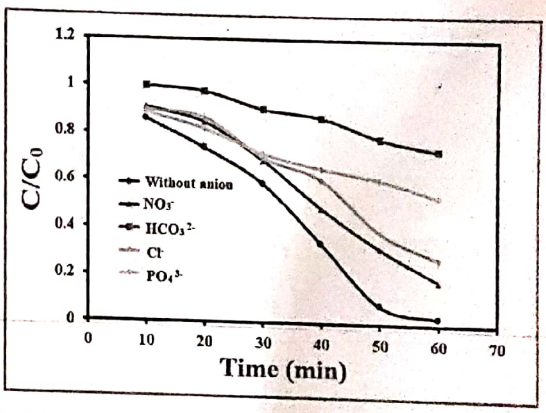

Fig. 9. Effect of electrolyte for degradation of Crystal violet dye in presence of ZnO, Ni/ZnO, and Fe/ZnO.

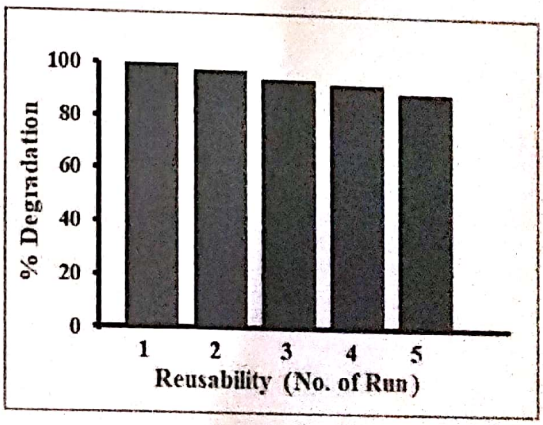

Fig. 10. Reusability tests for modified ZnO catalysts at CV dye.

Table 1
Comparison among Fe/ZnO catalyst and reported ZnO-based nanomaterials for photocatalytic degradation of different dyes.

Sr. No.	Material	Synthesis Method	D (%)	Source of light	Dye	Time in Min.	Ref.
1	Ce/ZnO	Sonochemical method	99	Sun-light	Crystal violet	100	[59]
2	ZnO/GO	Co-precipitation	99	Visible light	Crystal violet	240	[60]
3	Mn/ZnO	Chemical Co-precipitation method	99	UV	Methylene Blue	120	[61]
4	Ag/ZnO	Co-precipitation	82.15/97.36	UV	Methylene blue/Brilliant Blue	180	[62]
5	Cu/ZnO	Co-precipitation	90	UV	Crystal violet	90	[63]
6	3.5 % Fe/ZnO	Co-precipitation	99.88	UV	Crystal violet	60	Present Work

hazardous dye.

CRediT authorship contribution statement

Ravindra Haribhau Waghchaure: Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Writing – review & editing, Software, Validation. **Vishnu Ashok Adole:** Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Writing – review & editing, Software, Validation. **Sachin Shivaji Kushare:** Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Writing – review & editing, Software, Validation. **Rahul Ashok Shinde:** Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Writing – review & editing, Software, Validation. **Bapu Sonu Jagdale:** Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Writing – review & editing, Software, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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पेटेंट कार्यालय का एक प्रकाशन
PUBLICATION OF THE PATENT OFFICE

Design Number	374252-001
Class	24-02
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Date of Registration	16/11/2022
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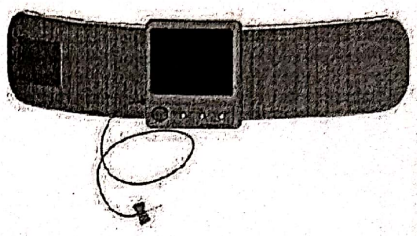

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NECESSARY STEP TO BE UNDERTAKEN FOR YOUNG-ADULT HEALTH

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Abstract

Introduction: In the introduction part, there is a details background related to the topic of steps for young adults' health and an introduction to their health.

Literature review: The literature review consisted of a detailed discussion about different topics of the research. There is also a theory that is related to the health recovery of young adults.

Methodology: It contains the steps that have been followed in the whole research and the process of data collection that is used in the present study.

Findings: Findings of the research shows the total collection of data from different secondary resources that are gained by the researchers.

Discussion: In the discussion, there is shown the similarity and dissimilarities that have gained in the literature review and the findings.

Conclusion: The conclusion shows the overall summary of the research that has been gained from the study.

Keywords: Mental health, young adults, physical health, physical activities, depression

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Introduction

The physical and mental health of the young generation must be maintained as they are the primary source of productivity for any country. It has been seen many times that, as they are not mature enough at a young time, sometimes they are engaged in different activities and habits, which are not suitable for their health (Salaheddin & Mason, 2016). Nowadays, the addition of internet games, too many social media activities, different online poker games related to prizes or rewards, different kinds of addition of food, alcohol and other harmful addition may hamper the physical and mental health both being faced by amount young generation. In the year 2022, it is seen that the pound people of UK in 68% respondents have given responses as they were confident about their physical health. There were 63% of people were happy with their state of mental health. There were 6.8% to 14.4% of young people who reported that their mental health was in the lowest range (Statista, 2020).

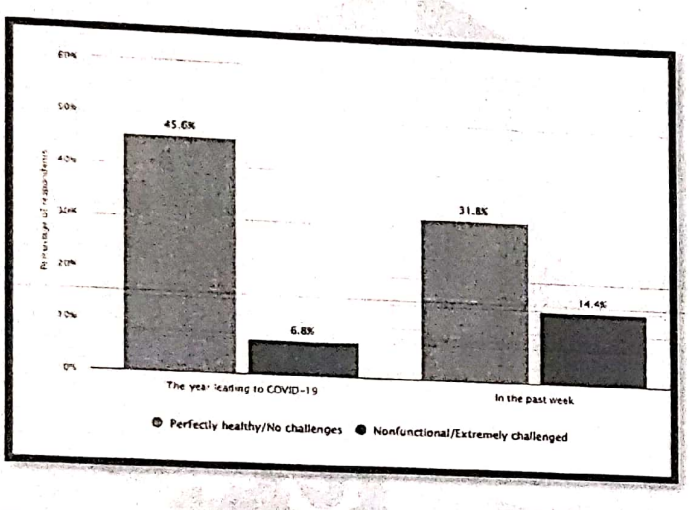

Figure 1: Percentage of young workers who reported their mental health

(Source: Statista, 2020)

Some steps should be taken to maintain the health of young people from the side of parents and the sid of governments also. There should be some rules and regulations or some programs that may help to make them more conscious of their physical and mental health (Liu et al. 2020). Some activities and programs or workshops may also help the young generation to inspire them for being more constructive.

Aim

The main of the research is to find the necessary steps that should be taken for young adult health and to make them fitter mentally and physically.

Research objectives

The main objectives of the research are:

RO1: To find the concept of young adult health and its importance for the country and society

RO2: To know the impact of weak mental and physical health on the young generation in any country or society

RO3: To investigate the challenges those are being faced by the young generation for bad and weak mental and physical health

RO4: To recommend the steps that may be helpful for enhancing the mental and physical health of the young generation to mitigate their challenges

Research questions

The questions of the research are:

RQ1: What is the concept of young adult health and the importance of thier health for any country and society?

RQ2: What is the impact on society and the country of the young generation of whose mental and physical health is weak?

RQ3: What are the challenges faced by young adults who have weak mental and physical health and what are the effects of it?

RQ4: What are the necessary steps those should be taken for enhancement of the physical and mental health of young adults to mitigate the issues?

Literature review

Importance of young adult health

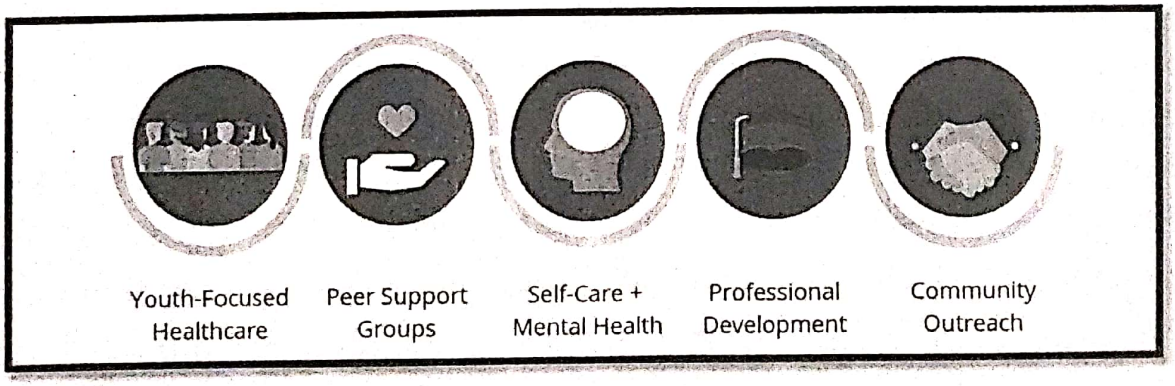

Figure 2: Young adult health circle of care

(Source: Han et al. 2018)

A good food habits, a healthy lifestyle, and strong mental power are the main key points of the young generation to make a good life. If the young health of any country is not mentally and physically strong, then the productivity of the country and the particular society will not be grown. As per the views of Ödling et al. (2020), the young generation, if their mental and physical health is not good, would not contribute to themselves and to their country also. On the other hand, it is also seen that a strong and educated young generation is the main pillar of the development and growth of any society which is a good sign for the overall development of the country (Han et al. 2018). If young adult health is not good, then there may be many activities that may hamper the normal life of people in society. Therefore, young adult health is too important for any society.

Steps that may help to enhance young adult mental health

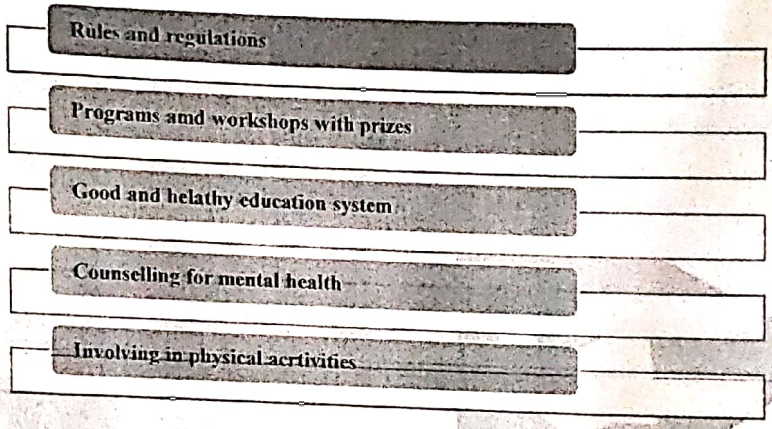

Figure 3: Steps for enhancement of young mental health

(Source: self-made)

Government should make some rules and regulations to prohibit of addiction to bad things that are affecting the mental and physical health of the young generation. Smoking and alcoholic materials should be prohibited by the young generation to make them far from addiction and therefore, the government should make some rules (Lee, Cadigan & Rhew, 2020). There should be some physical activities or programs with prizes or opportunities that may attract the young generation. It may be one of the ways to engage them with physical activities. Online addiction games and poker games should be rules with age restrictions and strong actions should be also taken against them. On the other hand, workshops and program competitions should be done (Siemons et al. 2017). The education system has to be reformed and this should also include healthy activities that may attract the young generation to become engaged. Free counselling should be done for treating the young who are mentally weak or facing issues. All of these activities may be helpful for the enhancement of the life of the young generation.

A Theory of mental health recovery

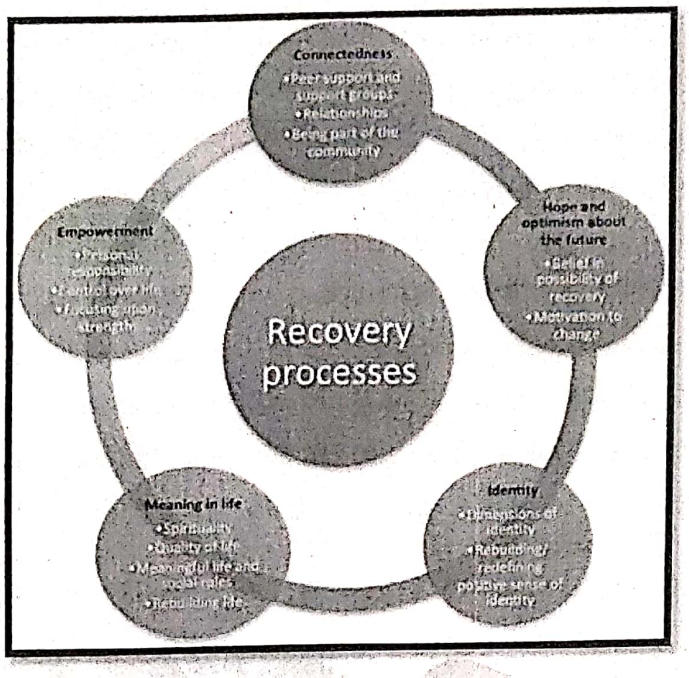

Figure 4: Theory of mental health recovery

(Source: Winsperet al.2020)

The theory of mental health recovery is suggested that, for the development of the development factors, recovery of young mental health occurs. It is also connected with the ecological context of the complex hierarchical social relationship that is interconnected with different things (Sanders et al. 2015). The orders of the hierarchy are the parents, young persons, and services of professionals, schools, and society and other representatives of the society (Winsperet al.2020). This theory can help to enhance young adults' health and this may be helpful for the young to enhance their mental and social health under the hierarchy. If they are faced with any issues, then they may take the help of their parents, schools, and teachers to solve their issues (Vanaken&Danckaerts, 2018). This may help the young generation to mitigate the issue related to mental and physical health.

Literature Gap

In this study, there are some points that have not been covered due to a lack of time and space. Here, the recovery of mental health has been stated. But the other studies have not included the perspectives of the people at categorized manner especially in the field of young and aged people. Young adults may have some issues top contact with their parents and teachers related to their mental and physical health sometimes has been covered in this research and the mitigation ways of these issues also have not stated in this present study. This is the main gap of the present study.

Methodology

In the present research, a secondary thematic research process has been followed. The research is followed the inductive research design that is helpful to investigate the secondary data that have already existed in different secondary data sources (Wei et al. 2016). The data collection method is. Secondary qualitative data collection process has been taken. Secondary data are collected from different sources of secondary data that are researched previously (Sileyew, 2019). Here, different journals that are valid from Google Scholar, articles, newspapers and from different websites that are full of information related to the topic of steps for adult health are taken. The research papers are not older than 5 years and all of the research papers are valid and related to the topic of the research. All ethics and rules of research have been maintained in the study. For secondary research, it is necessary to cite properly and maintain the copyrights of the journals (Roh, Heo&Whang, 2019). All of the rules and ethics are maintained in the present research.

The concept of young adult health and its importance for the country and society

Young adult health can be defined as the health of the young or youth of any society and their mental and physical health condition. It is important for everyone to become fit and healthy (Knapp & Wong, 2020). For young people, it is necessary to become fit related to their health issues and their mental condition as they are the main source of productivity of the country and society. If they are firm, then the society will be more developed. If their health is not good, the development of society will be at stake (Salaheddin& Mason, 2016). If the young adult is not too active in social development, the country may be affected. If the young adults are in addition, and their mental health is weak, then performance in national and international fields of the country will be weak.

The impact of weak mental and physical health on the young generation in any country or society

Mentally and physically weak adults may face depression in their mind and this is a great issue now among the whole world. Young adults are now connected with the virtual world and they are not related to physical works and activities (Crane et al. 2019). This is creating a great issue in their physical health as well as mental health also. As there are no such physical activities their body is not too strong to work for long time. Mentally depressed young people are not attentive to their academics and therefore, their career is at stake (Lee et al. 2020). The education of the countries is not being developed and the leaders of the future country are also in danger (Arango et al. 2018). There is increasing antisocial activities those are not wanted. The overall development of the country is not facing growth.

The challenges those are being faced by the young generation for bad and weak mental and physical health

The challenges those are faced for weak mental and physical growth of the young adults are, the development of the country are damaged. The education system of the country is also being affected. The academic performance of the students is being hampered. The career growth is los hampering (O'Connor et al. 2018). The students are getting into depression and sometimes they are doing suicide for their performance, anti-social activities are also increased. The addiction of alcohol, smoking is also being increased day by day. Development in the sports field and activities are also being decreased as the amount of people engaged in the physical activities is described day by day (Barariet al. 2020). Overall, the rate of mortality in small age is being increased, which is not good for any society.

1The steps that may be helpful for enhancing the mental and physical health of the young generation to mitigate their challenges

Government should take policies and rules and regulations to decrease the level of addiction. The parents should also take care about the mental and physical health of their children at a young age also (Salaheddin& Mason, 2016). They should talk freely with them about their issues. If they are depressed, then they should be taken for counseling. Workshops, programs should be done to encourage them to become engaged with physical activities.

Discussion

In literature review, it was seen that the mental and physical health of the young adults are being hampered and as a results, total development of the society and country are hampered. In finding, there is found the similarity that weak mental and physical health of adults described the development of any society. It has been also seen that the government should take some rules to decrease the rate of addiction among young people. Workshops, programs, help of parents, teachers and the counseling process may help the students to enhance their health (Giorgi et al. 2020). These steps may help them to engage with physical activity. Those are the best ways to enhance their work power and development in life.

Conclusion

Thus, it can be concluded that, Government, parents, teachers, and social workers should take steps for handling the mental and physical health of young adults. They are the main future of the country. At the end of the research, it is found that if the young adults are weak in any country or society, the development of that society is next to impossible. It is also seen that the mental and physical health of young adults is also increasing because of digital systems or virtual world engagement.

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THE CONSEQUENCE OF CHEMICAL USE ON *CERASTUS MOUSSONIANUS* HATCHABILITY

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Abstract
Cerastus moussonianus (Gastropoda: *Enidae*) Petit, 1851 is a land snail, found in gardens, cultivated field, compounds, road sides, underside the stones and woods etc. in Maharashtra. Its population reaches at high peak in the rainy season. They come out from the shell when environment is favorable (no matter whether it is day or night time) for the food and mating. *C. moussonianus* is known to cause severe damage to the plants, especially the vegetables in the fields and home gardens. Through regular field and laboratory observation, the mating behaviour viz. duration of mating, courtship behaviour, egg nesting behavior and oviposition were studied. The snails were supplied with fresh *Aloe vera* and *Brassica* leaves as food after every 24 hrs.

Keywords: *Cerastus moussonianus*, Imidacloprid, Cartap hydrochloride, hatchability etc.

Introduction

Cerastus moussonianus is a land snail, found in gardens, cultivated field, compounds, road sides and underside the stones and woods etc. in Maharashtra. Its population reaches at high peak in the rainy season. They come out from the shell when environment is favorable (no matter whether it is day or night time) for the food and mating. In unfavorable environment (e.g. when temperature rises) they move towards the dark region like soil crevices and underside of stones or wood where sun rays cannot reach withdrawing all their parts into the shell and remain in the same condition in summer.

Snail extends its body at the time of food searching, mating purpose and migration. When it extends fully measures about 1.5 to 2.0cm in length and nearly 0.75cm in width. It is broader in the middle and slightly tapers towards both the ends. Two pairs of retractable tentacles are present on the head. Anterior tentacles and posterior tentacles, anterior tentacles serves for smelling and posterior tentacles bear eyes. At the base broader part is present called foot. This secretes mucus while dwelling. The young snail exhibits the pale translucent color while it is dark in adult with light black spot of mantle cavity. Shell with six whorl coils along hollow axis known as collumella. The opening is located at the frontal basal part of the head. *Monacha obstructa* (Pfeiffer, 1842) (Hygromiidae) is the most common snail species on cultivated crops and it is recorded in high population density on egyptian clover, cabbage, green beans, maize and cucumber (Shoieb, 2008). Mollusks are ecologically important and also serve as bio-indicators and they play a fundamental role in the protection of water ecosystems by recycling nutrients and existing as food for assured aquatic animals (Giri and Wankhedkar, 2022).

C. moussonianus is known to cause severe damage to the plants, especially the vegetables in the fields and home gardens. It causes extensive damage to the crop plants in India (Magare, 1991). The biochemical effect of Cartap hydrochloride and Imidacloprid on the Albumin (ALB), Alkaline phosphatase (ALP), Glucose (GLU), Total Proteins (TP) and Uric acid (UA) with the respect to toxicity and mode of action of these pesticides in the land snail *Cerastus moussonianus* was studies by Wankhedkar and Bhavsar (2015). Ecology, evolution and phylogeny, behaviour, and reproductive biology can all benefit from

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understanding life strategies. Furthermore, this knowledge is necessary for defining management methods for land snail populations on the verge of extinction, as well as pest population control (Picoral and Thome, 1989). When the links between growth, reproduction, and lifespan patterns are clarified, terrestrial mollusk life history strategies may be resolved.

Few field studies have focused on apple snail population dynamics (Burky, 1974 and Lum Kong and Kenny, 1989). The majority of the studies on the longevity of terrestrial molluscs and its relationship with life history traits involve species from temperate regions (Baur and Baur, 2000; Heller, 2001; Hommay, et al., 2001 and Ocana, 2003). Reproduction is continuous in tropical areas and the duration of the reproductive period decreases with latitude to a minimum of six months in the southern limit of its natural distribution (Martin, et al., 2001). There are a finite number of resources accessible for various biological activities. As a result, tradeoffs between life history features like reproduction, growth, and lifespan must exist. Delaying reproduction by extending the time it takes to attain sexual maturity, for example, can result in greater longevity (Zera and Harshman, 2001). International concern about the Argentinean apple snail *Pomacea canaliculata* (Lamarck, 1822) rose enormously when it became established as a serious rice pest in Asia (Estebenet and Martin, 2002).

Land snail collecting can range from a form of recreation to a serious scientific effort that leads in significant contributions to scientific knowledge. Many factors potentially influence life history traits of *P. canaliculata*, but the published information allows us to discuss only the proximal effects of some of them at the organismic level (Estebenet and Martin, 2002). The aim of this study is to analyze the information on *Cerastus moussonianus* as far as the life history is concerned on which meager work has been done by the workers.

Material and Methods

Through regular field and laboratory observation, the mating behaviour viz. duration of mating, courtship behaviour, egg nesting behavior and oviposition were studied. The snails were supplied with fresh *Aloe vera* and *Brassica* leaves as food after every 24 hrs. The unconsumed parts of the food, faecal pellets as well as the dead snails were removed regularly to maintain strict hygienic conditions. The weight and diameter of freshly laid eggs were measured with the help of an electronic balance and a centimeter scale respectively. Incubation period and hatching percentage were calculated from the emergence of juvenile snails from the eggs. The study was carried out under laboratory and natural conditions. Prevailing temperature and humidity in the laboratory were recorded. To characterize life history traits of *C. moussonianus*, we quantified for each replicate colony the pattern of survival, changes in mean animal size, the date of onset of oviposition activity and the daily reproductive output. The size of each snail was determined by measurement of shell diameter. Up to the age of 90 days shell diameters were measured at 15 day intervals. Thereafter, measurements were undertaken at 30 day intervals. The first presence of eggs in the terrarium was taken to indicate that the snails have reached sexual maturity. To record deaths, the number of oviposition events and the number and size of eggs clutches, the snails were observed daily from the first presence of eggs until death of the last individual. Growth rate was calculated as the differences in changes in shell diameter divided by number of days between the measurements. The data were expressed as mean per replicate and then averaged across the three replicates to provide parameters of life history traits applicable to groups of 30 snails. Those data were subjected to detect differences in growth of the snails during the juvenile (before the first oviposition event) and adult phases of the life cycle.

3.2.1 Collection of test animal

Adult snails of *C. moussonianus* were collected by hand picking from infested gardens, Pratap Philosophy centre, roadside area and college premices of Amalner Taluka during the rainy and winter season.

3.2.2 Preparation of terrarium

Archer (1937) gave detailed instructions for converting an aquarium or a flowerpot into a snail terrarium. Carmichael (1937) presented methods for rearing slugs, including handling instructions for their eggs and juveniles. Krull (1937) gave directions for establishing a terrarium suitable for large species, such as

Mesodon thyroidus. Sturm, et al. (2006) gave detailed information about rearing terrestrial gastropod. Grimm (1974) addressed and proposed solutions to the different challenges that snail raisers face. The obtained snails were transferred in terrarium (60×30×30cm) which is covered by sponge internally to maintain humidity and surface is covered by metal wire net for ventilation. The terrarium is filled with moist sterilized sandy loamy soil ½:1 (w:v) and fed on fresh leaves of *Aloe vera*, boiled egg pieces, chalk dust, cabbage and lettuce etc. for 14 days to be laboratory acclimatized (photoperiod 14L: 10D; temperature 27-32°C; relative humidity 90% from June to Sept.).

3.4.1 Food

Shoaib, et al. (2010) used the fresh cabbage leaves as a food for *Menacha obstructa*. Omole, et al. (2011) provided the pineapple waste to *Archachatina marginata* as a food.

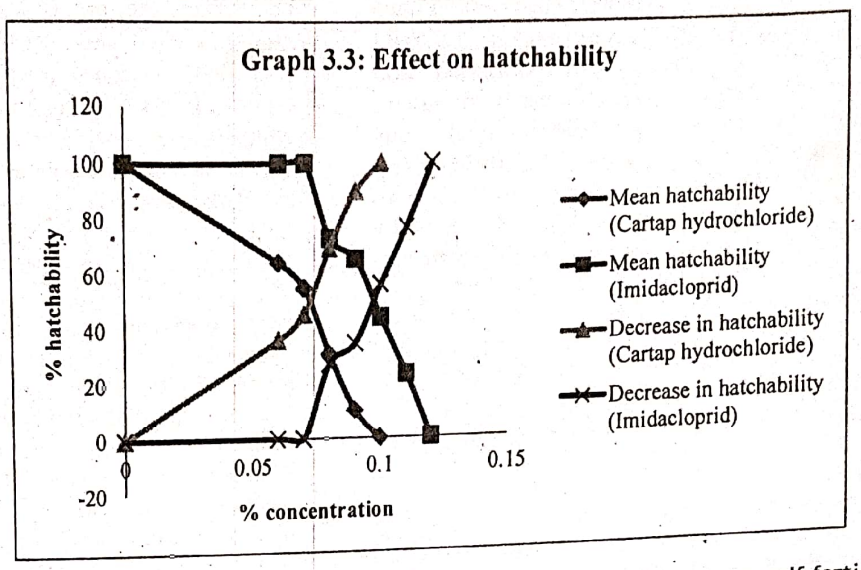
In present study *Aloe vera* was offered to the snail and during the experiment and in culture medium chalk dust, lettuce, boiled egg pieces, etc. are offered along with. The snails were treated with food diet Cartap hydrochloride concentration 0.06, 0.07, 0.08, 0.09 and 0.10% respectively and with Imidacloprid concentration 0.08, 0.09, 0.10, 0.11 and 0.12% respectively found in the previous research of Wankhedkar, et. al. (2011).

Result and Discussion

The effect on the hatchability was encountered in the eggs laid during the Treatment and % was calculated in mean±SE. Eggs hatched after 4-6 days of laying. In comparison with control 100% hatchability treated with Cartap hydrochloride, the hatchability was decreased in the snail by 35.8, 45.2, 69.2, 90 and 100% as per the concentration increases 0.06, 0.07, 0.08, 0.09 and 0.10% respectively and with Imidacloprid the food consumption was decreased in the snail by 26.8, 34.6, 56, 76.8 and 100% as per the concentration increases 0.08, 0.09, 0.10, 0.11 and 0.12% respectively (Graph 3.3) (Table 3.2).

Food treated with	Concentrations (In %)	Mean hatchability in %	Decrease in mean hatchability in %
	Control	100	00
Cartap hydrochloride	0.06	64.2±1.01	35.8
	0.07	54.8±0.96	45.2
	0.08	30.8±1.06	69.2
	0.09	10±0.70	90
	0.10	00	100
Imidacloprid	0.08	73.2±1.01	26.8
	0.09	65.4±1.28	34.6
	0.10	44±0.70	56
	0.11	23.2±0.66	76.8
	0.12	00	100

Table 3.2: Effect on hatchability



Saha and Roy (1994) stated that incubation period of eggs in *M. tugurium* ranged from 18.4 days to 22.17 days and percentages of eggs hatched were 97.10% and 99.91% under laboratory conditions (16.0-21.5°C). From the result, it is evident that the incubation periods were 14.0 to 18.4 days and percentage of eggs hatched were 94.44% to 98.66% under laboratory conditions (21.44 – 29.18°C) for *M. sequax*. Shoaib, et al., 2010 observed the effect of Nimbecidine® on the hatchability of *M. obstructa* and found that the eggs treated with highest concentration of Nimbecidine® (10 ml/l) caused 100% mortality of eggs. The mean egg production was between 20 and 50 percent at lower concentrations, based on the concentration level. Mean values of Nimbecidine® lethal concentrations LC_{20}, LC_{50} and LC_{90} for the eggs were 0.80 (0.50–1.28; 95% confidence interval) ml/l, 2.18 (1.71–2.78) ml/l and 10 (6.88–14.52) ml/l, respectively.

In present study the 100% mortality was recorded at 0.10% of Cartap hydrochloride and 0.12% of Imidacloprid which is matches with the result of Saha and Roy, 1994 and Shoaib, et al., 2010

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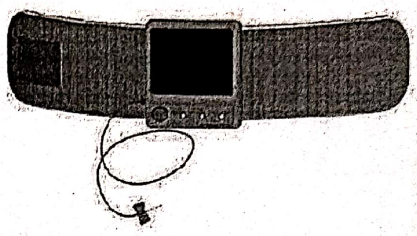

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PUBLICATION OF THE PATENT OFFICE

Design Number	386132-001
Class	24-04
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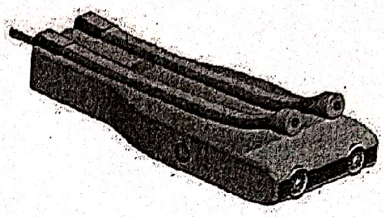

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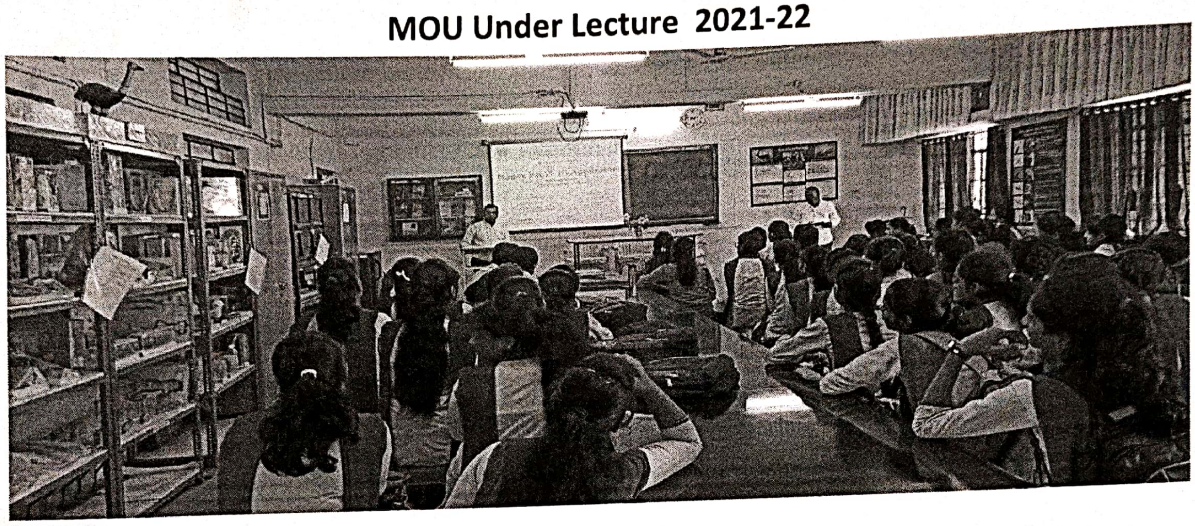
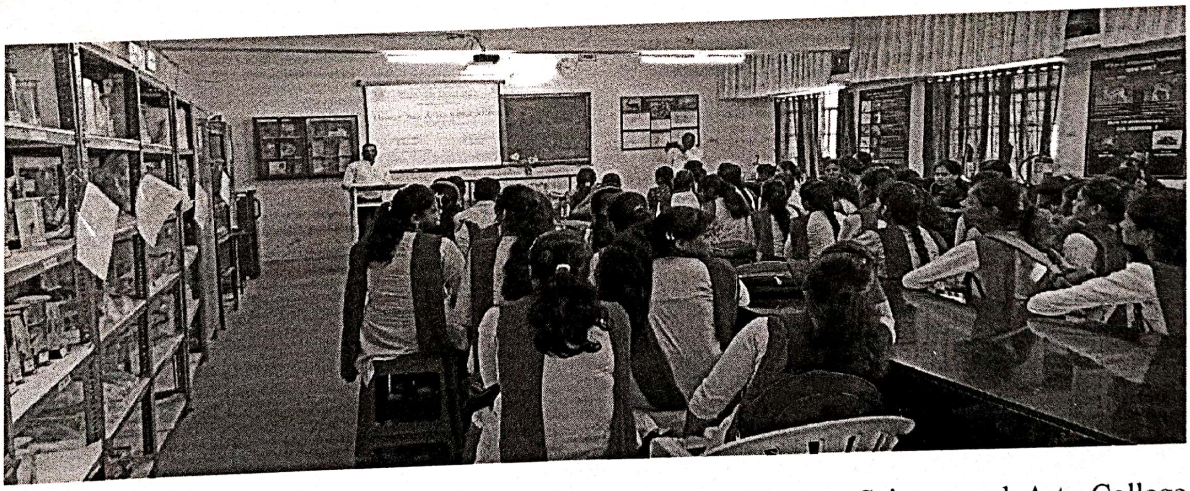
MOU Under Lecture 2021-22





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ASSESSMENT OF WATER QUALITY USING PHYSICO-CHEMICAL PARAMETERS OF KOTMARA RESERVOIR SANGAMNER TAHSIL, MAHARASHTRA, INDIA

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ABSTRACT

In the present investigation the physico-chemical parameters of three locations of Kotmara Reservoir Tahsil in Sangamner district Ahmadnagar of Maharashtra during winter, summer, monsoon and post-monsoon period in 2018 and 2019. The water quality of different parameters temperature (T), pH, turbidity(NTU), total hardness (TH) , free CO_2 (FCO_2), dissolved oxygen (DO), total dissolved solids (TDS), biological oxygen demand (BOD), total alkalinity (TA), chloride (Cl), carbonates (TC), bicarbonates (TBC), nitrate(NO_3), calcium (Ca), magnesium (Mg), potassium (K) and sulphates (SO_4) were analyzed. The result shows that the seasonal variation in their concentration of the selected locations for all seasons. However, maximum physico-chemical parameters concentrations were observed period P2 (Summer) as compared to other periods during 2018 and 2019. Minimum physico-chemical parameters concentration was found in P3 (Monsoon) during 2018 and 2019. Overall investigation, we observed that the water quality of Kotmara reservoir is very good for drinking and irrigation. But, huge environmental variation will be observed in the future, therefore, I suggested that the proper management of the reservoir is essential for the quality of water.

Keywords : Physico-chemical Parameters, Water quality and Seasonal variations

INTRODUCTION

Water is one of the most essential items needed by living being for their survival, growth and maintains an ecological balance between various groups of living organisms and their environment (Santosh Kumar, 1984). All living organism is depending on the water, and water exists in nature in many forms like clouds, rains, snow, ice and fog. However, chemically pure water does not exist for more time in nature. Even while falling, rainwater picks up small amount of gases, ions, dust particles and particulate matter from the atmosphere. Then, as it flows over the surface of earth, it dissolves and carries some of it. These chemical and physical impurities get mix with water. Water also mixes with industrial solvents, metals, acids, salts, sediments, pesticides, herbicides, plant nutrients, decaying animals, vegetable material and living microorganisms such as algae, bacteria and viruses.

Therefore, it is necessary that the quality of drinking water should be checked at regular time of interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. Hence, Smitha and Shivashankar (2013) reported that, water quality assessment involves analysis of physico-chemical, biological and microbiological parameters. Similarly, many researches are work studies in the physico-chemical characteristics water with different region (Dhanaji, *et al.*, 2016, Umerfaruq and Solanki, 2015 and Qureshimatva *et al.*, 2015).

The Kotmara dam (Ambidumala Project) is a small fresh water reservoir and minor irrigation project. This reservoir is situated, on Kas river, near Ambidumala and Kurkutwadi villages, west of Bota village. This area is hilly with moderate rainfall. The reservoir is mainly used for agriculture and drinking water purpose. Therefore, it is an urgent need to assessment of physico-chemical properties of water. Hence, in the present investigation to analysis physico-chemical parameters of water is determined which revealed in the Kotmara reservoir, Sangamner, Ahmedangar, Maharashtra, India.

MATERIAL AND METHODS

Study area

Kotmara reservoir is a fresh water reservoir of Sangamner taluka, Ahmedangar, Maharashtra, India. The dam was constructed on Kus river in 1989-1992 and It is handed over to Ahmednagar irrigation department in November 1993. The total catchment area is 30.50 sq. miles and total command area is 1010 hectors.

Selection of Sampling Locations:-

The water quality assessment was carried out from water Kotmara reservoirs. The water samples were collected from three different locations (K1, K2 and K3) of the reservoirs (Fig.1). The three locations of Kotmara reservoirs are classified in below.

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Aquatic macrophytic diversity in Kotmara reservoir of Sangamner Tehsil, Ahmednagar, Maharashtra

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Abstract

In the present experimental, study the algal aquatic macrophytes diversity of Kotmara reservoir, Taluka Sangamner, District Ahmednagar, Maharashtra. The present experiment was conducted in the laboratory of the Department of Botany, MJM, Arts Commerce and Science College Karanjali during the period of 2004 to 2005. During the experimental investigation, three different sites (K1, K2, and K3) were selected for the collection of aquatic macrophytes samples. The present study total of 21 species was recorded throughout the year and maximum plant diversity was recorded in winter as compared to summer and rainy seasons. *Chara* and *Nlitella* are the most dominating algal macrophytes observed in all three selected locations in Kotmara reservoir. During the investigation, the sites K2 and K3 found the highest aquatic macrophytic diversity as compared to the K1 site.

Keywords: *Chara, nlitella*, macrophytes, Kotmara and diversity

Introduction

The standards of water quality vary significantly due to different environmental conditions. High populations of microorganisms present in water cause health hazards. Swimming, fishing, rafting, boating, and industrial effluents are some more causes for the deterioration of water quality. Water quality depends on local geology and ecosystem and human interrelation such as sewage dispersion, industrial pollution, etc. Physical, chemical, and biological studies of the reservoirs are some aspects of hydrobiology. Aquatic plants are good indicators of water quality. So, the density and diversity of macrophytes depend on the quality of water in the reservoir. The seasonal changes are direct effects on the distribution and periodicity of macrophytes in the reservoir. It mostly depends on various factors such as light, temperature, depth of the water, etc. The aquatic macrophytes are of considerable ecological and economical importance (Wagh, *et al*., 2019) [14].

Numerous investigations have been made to determine the water quality and pollution status of various water reservoirs, Nandan and More, (2000) [15], Musaddiq (2000) [16], Wagh and Jondhale (2021A and B) [12, 13], and Bhatt and Patak (1992) [17]. Sanchita *et al*.,(2012) [8], reported that freshwater macrophytes play an important role in aquatic ecosystems by providing food, shelter and a variety of habitats for large numbers of organisms and some aquatic plants play an important role in removing pollutants from water. For that reason, such plants are used as a good indicator of water pollution such as, *Chara, Wolfia, Utricularia,* etc. Wagh *et al*., (2019) [14] Reported that it was observed that very few macrophytes were found in Deothan reservoir. Das and Datta, (2006) [3] also reported that the prepared macrophytic plant list. Therefore, present investigation to find out aquatic macrophytes diversity in Kotmara reservoir. It will help and understand how many types of macrophytes are observed in Kotmara reservoir. Kotmara reservoir (Ambidumala Project) is an important reservoir in the Sangamner Tehsil in Ahmednagar district and it is mostly used for drinking and irrigation purposes for the local peoples of Ambidumala and Kurkutwadi villages. So, such types of investigation are important for understanding the water quality of reservoirs and also finding macrophytic plants. Therefore, during the present study, the survey has been carried out on aquatic macrophytes of Kotmara reservoir.

Material and Methods

Study area

The Kotmara Dam is a freshwater reservoir of Sangamner taluka, Ahmednagar, Maharashtra, India. The dam was constructed on Kus River in 1989-1992 and It was handed over to Ahmednagar irrigation department in November 1993. The total catchment area is 30.50 sq. miles and the total command area is 1010 hectares.

Experimental Methodology

The water samples for pollution analysis were collected from the Kotmara freshwater reservoirs. The sampling method was used for the present investigation. Water samples during the experimental study period were collected from January 2004 to December 2005 in Kotmara water reservoirs. The algal samples were collected from three different sampling locations such as K1 (situated near the Kurkutwadi village), K2 (towards southwest near the end of the west weir), and K3 (near tower tank at the Southern extremity of the reservoir) of the Kotmara reservoirs. All selected sampling sites were selected after the survey and all samples were collected monthly in the morning between 6.00 a.m. to 10.00 a.m. The samples were observed on the spot in natural conditions. The macrophytes in the sites were packed in polythene bags and brought to the laboratory. The plant species were identified as per available literature (Cook, 1996 and Das *et al*., 2009) [2, 4].

Result and Discussion

Our experimental study to find out the aquatic macrophytic plants has been identified, selected three different sites of Kotmara reservoirs. All identified macrophytes plants in

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Phytoplanktonic diversity study in Deothan reservoir (Maharashtra)

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Abstract
Present study was carried out during 2014 and 2015 to study the phytoplankton diversity of Deothan reservoir (Maharashtra).Three different locations (D1, D2 and D3) were selected for collection of algal samples. Algae from seven classes have been observed and identified in the Deothan reservoir. The dominant class was Chlorophyceae (37 genera and 72 species). It was followed by 15 Genera and 37 species of Cyanophyceae and 9 genera and 24 species of Bacillariophyceae. The quantitative growth of algal density was found in winter and monsoon seasons, while minimum growth was observed in summers during this period. The maximum algal diversity observed in D1 and D3 location of Deothan reservoir.

Keywords: Deothan, diversity studies, phytoplankton and reservoir

Introduction

Deothan fresh water reservoir is an important reservoir near the village Deothan of Akole tahsil, Ahmednagar. It was constructed in 1993 and the total catchment area is 67.50sq miles. The storage capacity of the Deothan reservoir is 1060 mcft. and 230.67ha is a command area of this reservoir. This reservoir is situated in the northern part of Akole tahsil. The Deothan reservoir was constructed on Adhala River, the tributary of Pravara River. It originates near village Ekdara, 18 km upstream of the dam. This reservoir is mostly used for drinking, irrigation and domestic purposes. So, the human interface is directly involved and they affect phytoplankton diversity. In the present environmental situation, there is a need to analyze phytoplankton diversity of Deothan water reservoir.

The phytoplanktonic study is a very useful tool for water quality assessment and also contributes to an understanding of the basic nature and general economy of the lake ecosystem (Pawar *et al*., 2006) [17] and (Wagh and Jondhale, 2021A) [33]. The numbers of species of phytoplankton play an important role in determining the quality of the water body. Therefore, certain algae may grow in a specific quality of water. Hence, algal growth in a habitat that influences the ecosystem and also it directly affects the aquatic environment mainly the nutrient contents. However, the identification and assessment of biodiversity composition of a lake results in the conservation of the aquatic system (Goswami, 2012) [12].

Several researchers have been published their work on phytoplankton diversity in freshwater reservoirs. Rana and Palria (1988) [27] have surveyed the River Ayad which receives high amounts of domestic and industrial wastes and calculated the percentage of algae, where 50% belongs to blue greens, 33% to green algae, 10% to diatoms, and the remaining Euglenophyceae members. Pulle and Khan (2003) [26] also analysed the phytoplankton and recorded 43 species of which 18 were Chlorophyceae, 10 Bacillariophyceae, 10 Cyanophyceae and 5 Euglenophyceae. A number of research workers have published their work on aquatic environment and ecology of Phytoplankton in freshwater. More and Nandan (2003) [18], Sirsat *et al*., (2004) [30], Sushmita *et al*., (2017) [32], Priyanka and Nilima, (2017) [25], Alifha *et al*.,(2018) [2], Halder *et al*., (2019) [14] and Wagh and Jondhale, (2021B) [34]. In the present study attempt was made to study seasonal diversity and population density of phytoplankton in Deothan reservoir of Akole taluka.

Materials and Methods

Deothan fresh water reservoir is in the geographic region of the taluka Akole in the district Ahmednagar, Maharashtra (Figure 1). It is situated on Adhala river, near Deothan villages. The water samples for phytoplankton analysis were collected from the Deothan freshwater reservoirs. Monthly collection of algal samples has been carried out from three different sampling stations that were selected after survey such as D1 (Towards the Savargaon pat village), D2 (near the canal alignment) and D3 (southern region near pump house) of the Deothan reservoirs. Phytoplankton sampling on a monthly basis was carried out for a period of two year from January 2014 to December 2015. The samples were collected monthly in the morning between 6.00 a.m. to 10.00 a.m. The samples were observed on the spot in natural conditions and was preserved in 4% formalin and Lugol's solution. Samples were collected using plankton net, of mesh size 20. The macroscopic algae were collected in bottles and polythene bags. Fresh as well as preserved algal forms were observed under research microscope and identified with the help of standard literature and monographs Fritsch (1931) [9], Smith (1950) [31], Prescott (1950) [24], Desikachary (1959) [4], Misra (1940) [15] and Sarode and Kamat (1984) [29].

Sahyadri Shikshan Mandal,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth, Dist-Nashik,
Department of Chemistry

MOU Activity With

Department of Chemistry, Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar.

Department of Chemistry Sahyadri Bhujan Vidya Prasarak Samj Shaakar Maharshi Bhausaheb Santuji Thorat College of Arts Science and Commerce, Sangamner, organized as Guest lecture on "Analytical techniques and their application in laboratory" during 15th Dec, 2021. In this program Mr. R.M. Nikam explain which types of errors are occurred in the results and how to resolve these problems. The lecture was not only informative but also encouraged students Teachers and all the listeners to learn new things in Analytical techniques. Total 40 students benefited from this interactive session.

M.J.M.A.C.&S. Colleges Karajali Tal.Peth, Dist.Nashik

Principal
M.J.M. Arts, Commerce &
Science College Karajali,
Tal.Peth. Dist.Nashik

Phy

SahyadriShikshanMandal's,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Physics

MOU Activity With

Department of Physics, Sahyadri BhujanVidya PrasarakSamj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar.

Department of Physics, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organize One day state level online workshop on"INTRODUCTION TO PYTHON PROGRAMMING" on 22/02/2022 at 11:30 a.m.

Chief Guest and resource Person Prof. Vijaykumar Pande, Head, Department of Physicsof SahyadriBhujanVidyaPrasarakSamjShaakarMaharshiBhausahebSantujiThorat College of Arts Science and Commerce, Sangamner, delivered a lecture for workshop "Introduction To Python Programming.

On Introduction to Python programming provides an introduction to programming in the Python programming language for physics Students. Although the examples are drawn from first year physics, anyone who is familiar with, Simple Pendulum, Newton's equations of motions and ordinary differential equations will be able to follow. The overall goal is to enable students to Introduce Python programming and write short programs to solve their own numerical problems, no matter where the problems come from. Workshop contains introductory online class that teaches programming in the widely used Python language with applications to physics problems. This course covers the fundamentals of procedural and object oriented programming in Python together with the commonly used scientific libraries.

The Workshop was not only informative but also encouraged students Teachers and all the participants to learn python language, all the participants get benefited from this interactive workshop. This session was highly appreciated by the fellow participants.For the said workshop Principal Dr.D.D.Patil from S.M.B.S.Thorat College Of Arts , Science & Commerce Sangamner, Dist: A. Nagar Dr. Rahul A. Wagh, Mr. M.V. Jadhav, Mr.Tejas Kapadane, Miss S.A.Vaidya, Miss. KavitaBorse, Miss R.S.Naikwadi were present. The informative and skillful workshop culminated with a vote of thanks proposed by the Dr. Rahul A. Wagh.

Head
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Karanjali, Nashik-422 208

Principal
M.J.M. Arts, Commerce and Science College
Karanjali, Nashik-422 208

Sahyadri Shikshan Mandal's

M.J.M.Arts,Commerce&Science College Karanjali

Department of Mathematics

Report of the Activity

1. Name of the Activity: - Lecture for exchange of knowledge under MOU
2. Aim of the Activity: -
   a. To remove inferiority complex of students about solving simultaneous linear equations

3.Place of the Activity: - Department of Mathematics M.G.M. College of Arts, Science and Commerce, Karanjali Tal-Peth ,Dist- Nashik

4.Date of the Activity: - 21-10-2021

5.0rganizer: Department of Mathematics M.G.M. College of Arts, Science and Commerce, Karanjali Tal-Peth ,Dist- Nashik

6.Guest / Expert: - Dr. Milind M. Sakalkale

7.No. of Teacher Participated: - 02 (01 of S.M.B.S. Thorat College Sangamner and M.G.M. College of Arts, Science and Commerce, KaranjaliTalPeth ,Dist- Nashik)

8. No. of Students Participated: - 30

9.No. of Stakeholders Participated:---

10.0utcome of the Program: -
   a. Students get well acquainted with basic concepts like row echelon form, solution of system of simultaneous linear equations, basis and dimension etc.
   b. This lecture results to build confidence about Linear Algebra among students.

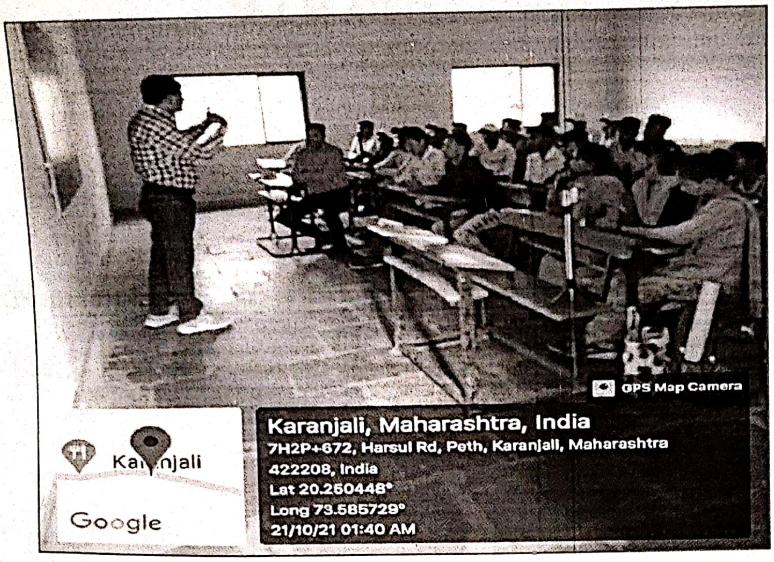
11. Highlight if any: -

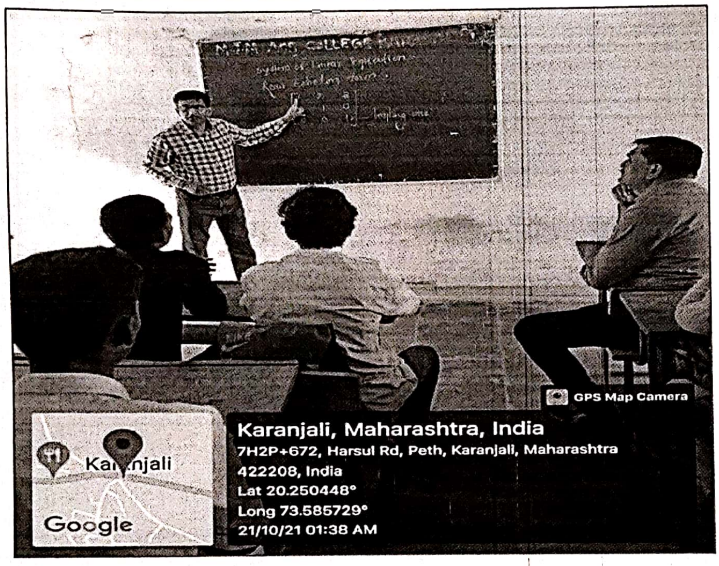
Head
Department of Mathematics

Head
Dept. of Mathematics
M.J.M.Art's Comm.& Sci.College
Karanjali, Tal. Peth (Nashik)

Principle

Principal
M.J.M. Arts, Commerce
and Science College
Karanjali, Nashik-422 208





SAHYADRI SHIKSHAN MANDAL'S

M. J. M. ATRTS,COMMERCE AND SCIENCE COLLEGE

KARANJALI, TAL-PETH, DIST- NASHIK

Department of Mathematics

Lecture for exchange of knowledge under MOU

Student Attendance

Name of Guest/ Expert: - Dr. Milind M. Sakalkale

Subject: - Complex Concepts in Linear Algebra Date: 21 -10-2021

Sr. No.	Name of Student	Class	Sign
1	Mahale Prithvik Laxman	F.Y.BSc	P.L.Mahale
2.	Gavit Mayur Devidas	F.Y.BSc	Mayur.
3.	Bhusare Yogesh Hariram.	S.Y.BSc	Yogesh.
4.	Aaut Tukaram manohar	F.Y.BSc.	Tukaram.R
5	Kamdi Vaishali Arun	F.Y.BSc	Vaishali
6	Tasware mayur yuvraj	S.Y.BSc	M.Y.T
7	Bhoye Kiran Kaushana	S.Y.BSc	Kiran
8	Pawar Sunil Janardhan	S.Y.BSc	P.S.Janardhan
9	Boke Gorakh Balu	F.Y.BSc	Gorakh
10	Jadhav Nishant Nandu	F.Y.BSc	Nishant
11	Khotare Lalita Rambhau	S.Y.BSc	Khotare
12	Bhoye Kiran Krushana	F.Y.BSc	Bhoye
13.	Gaikwad Anita Vishnu	S.Y.BSc	Agaikwad
14.	Mahale Kalyani Yashwant	F.Y.BSc.	Kmahale
15	Chaudhari Jivandas Ramesh	F.Y.BSc	Chaudhari
16	Patade Sakshi baban	F.Y.BSc	Sakshi
17)	Bhoye Vishesh Ashok	S.Y.BSc	Vishesh
18)	Pawar Sunil Janardan	S.Y.BSc	Sunil
19)	Gavali Harshad yuvraj	F.Y.BSc	Harshad
20)	Patade Sakshi Baban.	F.Y.BSc.	Sakshi
21)	Bhoye Kiran Kaushana.	F.Y.BSc.	Kiran.
22)	Gaikwad Kavita Arun	S.Y.BSc	Kavita
23)	Jadhav Abhishek Sanjay	S.Y.BSc	Abhishek.

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Sahyadri Shikshan Mandal's,
Mahant Jamanadas Maharaj
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MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Zoology

MOU Activity With

Department ofZoology Department of Zoology, Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar

MOU Under Lecture 2021-22

Dr. Prakash Wankhdakarand Dr.Niranjan Giri Delivering Lecture on "Morphology of Bombyx mori" at Department of Zoology, Sahyadri Bhujan Vidya Prasarak Samj, Sahakar Maharshi Bhausaheb Santuji Thorat College of Arts, Science and Commerce Tal- Sangamner, Dist-Ahmednagar, dated 15/01/2022

Principal
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Head
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Gokhale Education Society's
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Ref. No.

Date :
Date: March 11,2022

Workshop Title: Finger millet cultivation, conservation and promotion

Jointly organized by MJM Arts, Commerce and Science College, Karanjali

(Peth, Nashik District) and HPT Arts and RYK Science College, Nashik-422005.

Department of Botany of Karanjali and HPT Arts and RYK Science College, have been working together since 2011 for the Conservation of landraces and promotion of Finger millet with reference to Karanjali region. Fifty-five farmers (55) and seventy-five (75) were participated in the workshop. The region is popular for Millet cultivation, as majority of the farmers are tribals and have been using conventional seeds for cultivation. During the workshop details has been given on various issues deals with importance of landraces, its nutritional contents and advance agronomic practices.

Prof. Sanjay Auti
Head, Department of Botany
HPT Arts and RYK Science College,
Nashik

H.P.T. Arts & R.Y.K. Science College ★ NASHIK 05.

Dr.Avinash Jondhale
Head, Department of Botany
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Transition metals Fe^{3+}, Ni^{2+} modified titanium dioxide (TiO_2) film sensors fabricated by CPT method to sense some toxic environmental pollutant gases

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ARTICLE INFO

Keywords:
Modified TiO_2 sensor
SO_2 sensing
TEM
XPS
BET

ABSTRACT

The present investigation deals synthesis of undoped TiO_2, Ni^{2+} doped TiO_2, and Fe^{3+} doped TiO_2 nanoparticles by low-cost co-precipitation (CPT) method. The thick film sensors of all the fabricated modified TiO_2 nanoparticles were designed by a screen printing strategy. The prepared thick film sensors were characterized by various sophisticated techniques. The structural parameters of undoped TiO_2 and modified TiO_2 film sensors were characterized by X-Ray Diffraction (XRD) which confirmed anatase phase of TiO_2 lattice. The surface morphological properties of all the prepared materials were confirmed by means of scanning electron microscope (SEM). The energy dispersive spectroscopy (EDS) confirms the elemental composition of all the prepared materials. High-Resolution Transmission Electron Microscopy (HR-TEM) was utilized to investigate the crystal lattice of fabricated TiO_2 material. The HR-TEM results revealed the anatase phase crystal morphology of prepared material. The prepared TiO_2 materials were also characterized by means of X-Ray photoelectron spectroscopy (XPS) to confirm the surface doping, specific biding energies, chemical states and elemental composition of modified TiO_2 materials. The Brunauer–Emmett–Teller (BET) study was carried to investigate the specific surface area of all the prepared sensors. The Fe^{3+} doped TiO_2 sensor found with enhanced surface area (83.10 m^2/g) in comparison to Ni^{2+} doped TiO_2 and bare TiO_2 (67.34 m^2/g). All the prepared materials were investigated for gas sensing characteristics. The NO_2, SO_2, and CO_2 gases were investigated for all the prepared sensors. The reusability test confirms that the Fe^{3+} doped TiO_2 is reproducible and stable sensor for long time repeated sensing of SO_2 and NO_2 vapors. Importantly, Fe^{3+} doped TiO_2 sensor showed rapid response and recovery towards SO_2 and NO_2 vapors.

1. Introduction

The twenty-first century is known as the "Invention Century." In the fields of science and technology, the most significant inventions are made. Material technology is at the core of these innovative research applications. Material science has contributed a great deal to the world in the form of several advancements. The enormous research work in technological fields has changed mankind's life in many respects, and this extraordinary work in material science has inspired researchers to pursue more enticing work in technological fields such as engineering [1], biosensors [2] ceramics technology [3], supramolecular chemistry [4], computational chemistry of nanomaterials [5], sensors and transducers [6,7], advanced oxidation processes [8], mussel chemistry [9,10], automotive technology [11], molecular nanotechnology [12], nano-medicines and therapeutics [13,14], etc. As noted previously, there is a booming demand for nanomaterials-based materials in a variety of fields of technology. With the help of material science-based technology, the inventors are bringing their resources to work on a variety of technological advancements.

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Material science is characterized by innumerable types of materials, such as porous, macro, micro, and nanomaterials. Among these, the majority of investigators are considering nanomaterials as a safer and more promising material for addressing various technological and environmental challenges [15–19]. Environmental challenges are getting more severe in the form of several pollution these days [20]. The environmental protection agency (EPA) has issued a strong red signal for most Indian cities' air quality index (AQI) [21]. The world's most cities have dangerous AQI, which is a major area of concern [22]. According to EPA, the AQI has several categories, can be indicated by specific colors like orange, red, purple and maroon which are specifically indicated for situations of AQI like sensitive to hazardous [23]. This serious environmental issue can be treated by developing specific sensors to sense the particular gas vapors [24]. The sensors particularly chemosensors are based on semiconducting nanomaterials, most of the nanomaterials from d-block elements are based on the semiconducting nature [25]. These semiconducting nanomaterials are very easy to fabricate, along with being cost-efficient [26], non-hazardous [27], and having a resourceful construction process [28]. As a result of the advantages mentioned above, the majority of researchers are working on chemiresistor-based sensors fabricated from semiconducting nanomaterials [29,30].

There are many materials that are being utilized for the gas sensing applications. The common materials like ZnO, SnO_2, NiO, CuO, Co_3O_4, La_2O_3, CeO_2, Fe_2O_3, Fe_3O_4, CdS, TiO_2, MnO_2, $LaCrO_3$, Al_2O_3, ZrO_2, $NiFe_2O_4$, etc. are extensively utilized as sensor material to sense various gases [31–37]. The metal oxides and their modified sensors were found to be utilized for the sensing of gases like CO, CO_2, CH_4, NO_2, LPG, NH_3, H_2S, CH_3–OH, C_2H_5–OH, Cl_2, etc. [38–46].

Although the undoped materials were found to be very effective at sensing toxic gases, modified materials are showing better performance in similar applications [47,48]. Since the absorption of gases above their threshold limit causes a very dangerous, fatal, and hazardous health problem [49,50]. As a result, the effective sensor must detect the minute concentration of these. In comparison to the doped nanomaterial oxides (modified oxides), undoped nanomaterials oxides have many pitfalls, including small surface area, high band gap energy, lower agglomeration, and less accessibility which can be tackled by modification of the metal oxide structures [51–53]. Through the use of transition metal-doped metal oxides, nanocomposites, binary oxides, or CNT functionalized nanomaterials oxides, is a new trend in fabricating effective sensors with very high selectivity towards the selected gases [54–57]. Thus, in the current trend, transition metal doped oxides, nanocomposites based sensors, CNT doped oxides, etc focused on catalytic efficiency are more effective in terms of gas sensing.

Due to remarkable and promising properties, titanium dioxide (TiO_2) is an extensively investigated material for a variety of applications [58–60]. As a result, TiO_2 based materials are still being formulated and used in various fields of material science. In catalytical applications, nearly all morphological phases, such as rutile, anastase, and brookite, is well described and documented [61–64]. TiO_2 has certain inherent properties, such as a mild band gap, a large surface area, and the potential to act as a catalyst [65–67]. Even then, the researchers asserted that a small change in the lattice properties of TiO_2 makes it more efficient in fields such as gas sensing and photocatalysis [68–70]. In the recent research based on TiO_2 gas sensor, reported material; TiO_{2-x}/TiO_2-based hetero-structures were efficiently utilized to sense some reducing gases like ethanol, methanol, n-propanol and acetone vapors [71]. Similarly, TiO_2 based nanostructure materials were used as sensors for sensing gas and volatile organic compounds [72].

The purpose of this study is to use the co-precipitation approach to synthesize TiO_2 nanoparticles as well as Fe^{3+} and Ni^{2+} doped TiO_2 nanoparticles. The synthesized nanoparticles were well characterized by various analytical methods. The study focuses on the use of undoped and modified titanium dioxide nanoparticles for the detection of toxic gases like CO_2, CO, petrol vapors, and LPG. Both of these thick film sensors were utilized for the investigation of sensitivity, selectivity, response and recovery, reproducibility, etc. The transition metal-modified titanium dioxide thick film sensor was found to be very efficient for CO_2, CO, petrol vapors, and LPG vapors. In addition to above characteristic research work, the mechanism of modified TiO_2 sensor the comparative data of undoped and modified titanium dioxide sensors is represented and effects of dopants metal Fe^{3+} and Ni^{2+} is highlighted in the present research work.

2. Results and discussion

2.1. X-ray diffraction (XRD)

The synthesized materials undoped TiO_2, Fe^{3+} doped TiO_2, and Ni^{2+} doped TiO_2 materials were characterized by X-ray diffractometer Bruker D8 advance, Braggs scanning angle ranging from 10-90^0. The XRD spectrum of all prepared materials is as depicted in Fig. 1 a-c. **Figure 1 a-c** shows the different Braggs reflection peaks that can be assigned to the formation of anatase titanium dioxide nanomaterial. Although, TiO_2 exists in three different phases such as anatase, rutile, and brookite, here 2θ values for various Bragg's reflection peaks indicating the formation of anatase phase of TiO_2 nanoparticles. From XRD spectral images it can observe that there is no significant change in the anatase TiO_2 crystal lattice with a doping concentration of elements Fe^{3+} and Ni^{2+}. Although slight variation or shifting of 2θ values of Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 nanoparticles can be seen very easily, indicating slight modification in TiO_2 material due to doping of these elements. Since, doping concentration of elements probably imparts many lattice changes in host molecule like crystal defects, oxygen vacancies, F-centres, edge dislocations etc.

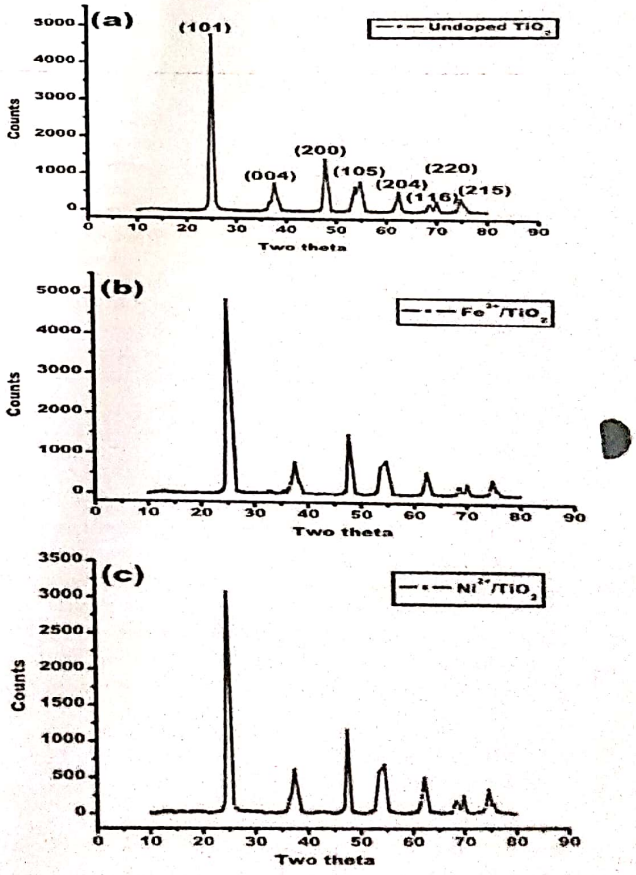

Fig. 1. (a) XRD pattern of undoped TiO_2 thick films, (b) XRD pattern of Fe^{3+}/TiO_2 thick films, (c) XRD pattern of Ni^{2+}/TiO_2 nanoparticles.

The 2θ values of diffraction peaks obtained from XRD data for undoped TiO_2 are 25.08, 37.58, 47.78, 53.67, 54.80, 62.42, 68.52, 70.00, 74.79 are assigning to the reflection of (001), (004), (200), (105), (211), (204), (116), (220) and (2015) planes. The diffraction peaks for 2θ values and hkl planes mentioned above confirms the formation of anatase TiO_2 nanomaterial. The JCPDS data cart number 21–1272 justifies the formation of TiO_2 material. Similarly, the XRD spectrum of Fe^{3+} doped TiO_2 nanomaterials have 2θ values are 25.15, 37.65, 47.85, 53.74, 54.86, 62.48, 68.57, 70.06, 74.85, indicating slight shifting of two theta values are assigning the (001), (004), (200), (105), (211), (204), (116), (220) and (2015) planes. The XRD spectrum of Ni^{2+} doped TiO_2 nanomaterials has 2θ values indicating shifting to a slightly lower 2θ values in comparison to the undoped TiO_2 and Fe^{3+} doped TiO_2 nanomaterials. The 2θ values can be assigning as 24.92, 37.42, 47.61, 53.53, 54.62, 62.28, 68.39, 69.81, and 74.65 to the reflection of (001), (004), (200), (105), (211), (204), (116), (220) and (2015) planes. The Debye- Scherer's formula (equation (1)) was used to calculate the average particle size of prepared sensor materials.

$$D = \frac{K\lambda}{\beta COS\theta} \quad (1)$$

where D is average particle size, K is constant (0.9–1), β is full width half maxima (FWHM) of diffracted peak, θ is the angle of diffraction. The average particle size of undoped TiO_2 nanomaterial calculated using equation (1) is found to be 18.33 nm, For Fe^{3+} doped TiO_2 nanoparticles it was 16.70 nm and for Ni^{2+} doped TiO_2 nanoparticles it was found to be 16.97 nm.

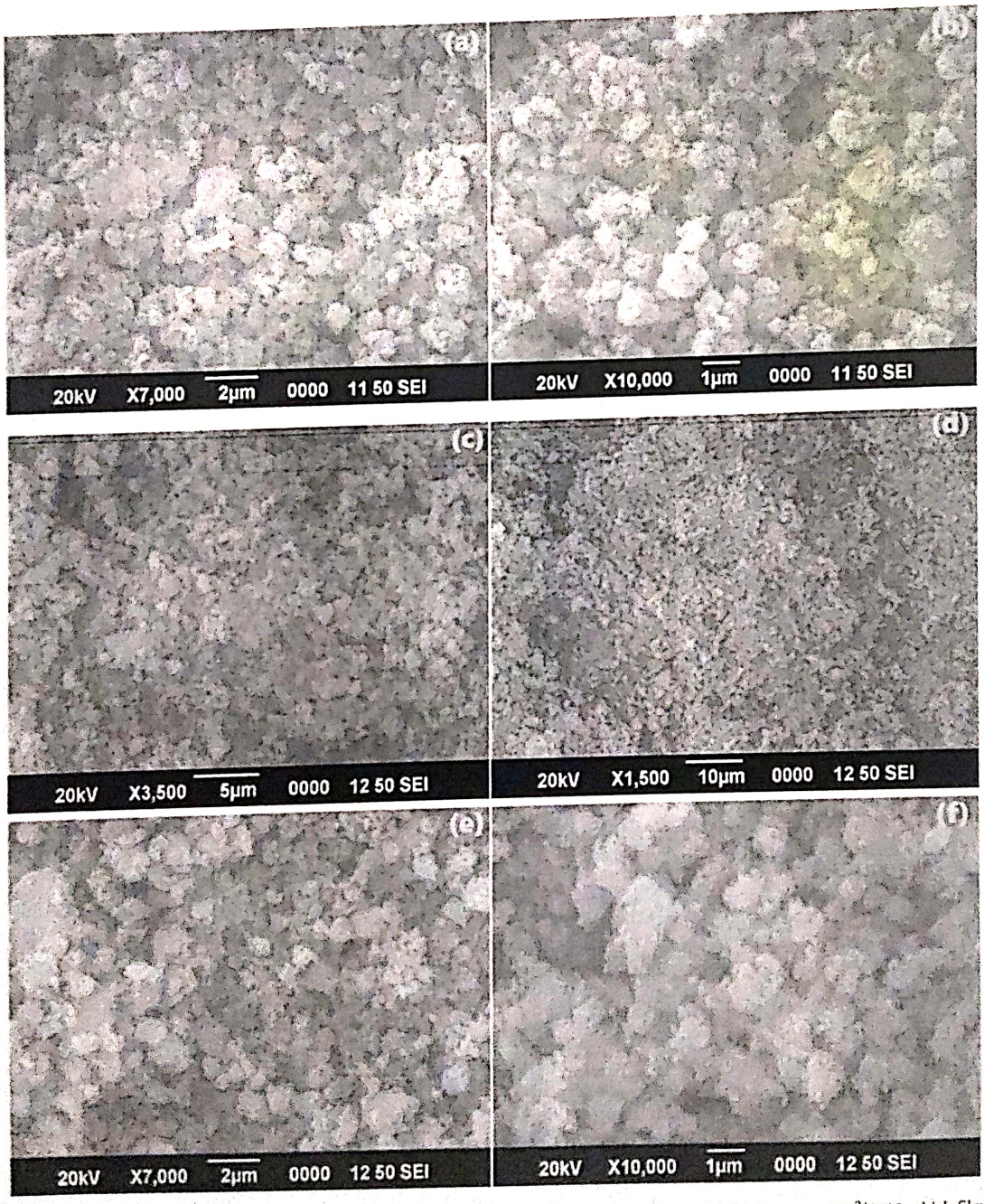

Fig. 2. (a,b) SEM images of undoped TiO_2 thick films, (c,d) SEM images of Fe^{3+}/TiO_2 thick films, (e,f) SEM images of Ni^{2+}/TiO_2 thick films.

2.2. High resolution scanning electron microscopy: (HR-SEM)

The SEM images of all the three prepared materials viz. undoped TiO_2, Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 nanomaterials are as depicted in Fig. 2 a-f. The surface micrographs (Fig. 2 a,b) of undoped TiO_2 material is showing very close agglomeration of tiny nanoparticles having heterogeneous and uniform porous surfaces over TiO_2 crystal lattice. Between, the close aggregation of various size nanoparticles small lumps, voids and small pits between the agglomerations can be observed. The smaller voids are the foremost features of nanomaterials for reinforcing the adsorption-related properties of solid materials, particularly for sensors. The another material i.e. Fe^{3+} doped TiO_2 nanomaterial, SEM images as depicted in Fig. 2 c,d. The images showing a smaller clusters of nanoparticles lumps together, with heterogeneous surface. The iron doped TiO_2 has found to greater surface area (from BET equation), since material is appearing to be more porous in nature, with smaller voids all over the crystal lattice. Similarly, the SEM images of Ni^{2+} doped TiO_2 as shown in Fig. 2 e,f, showing minuscule nanoparticles dispersed throughout the crystal lattice of nickel doped TiO_2 nanomaterials. This material is also appeared with the heterogeneous surfaces area with nanoscopic voids formation into entire lattice of Ni^{2+} doped TiO_2 due to close agglomeration of tiny nanoparticles improving more surface properties of this material to make it as good gas sensor for the adsorbate gas molecules. From overall BET analysis the iron doped TiO_2 has a more better surface area in contrast to the undoped TiO_2 and Ni^{2+} doped TiO_2 probably due to smaller crystallite size and improved agglomeration in case iron doped TiO_2 making good porosity possessing material with improved surface area for Fe^{3+} doped TiO_2 material.

2.3. Energy dispersive spectroscopy (EDS)

The elemental composition of undoped TiO_2 and Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 were validated from the EDS analysis. The EDS spectrum of the prepared materials showing the resoluted elements on EDS scale and their elemental composition is as depicted in Fig. 3 a-c. From Fig. 3a of undoped TiO_2 material it can be seen that titanium is sharply resoluted at 4.5 eV. While from Fig. 3b the Fe^{3+} doped TiO_2 showing the elemental composition and characteristics resolution of elemental iron and titanium. The Fig. 3b showing the sharp resolution of Ti at 4.5 eV and 6.5 eV EDS scale for iron. The EDS spectrum of nickel doped titanium is seen from Fig. 3c. Here the elemental Ni is resoluted at around 8eV, while the titanium is in the same scale of 4.5 eV. From the EDS spectrum of all the materials it can be concluded that the elemental Fe and Ni are successfully doped over the crystal lattice in their significant elemental composition. The results obtained from EDS are well justified by results gained from the XPS technique for surface characterization shown in Figs. 6 and 7.

2.4. High-resolution transmission electron microscopy (HR-TEM)

The lattice morphology of all the fabricated materials was investigated by means of high resolution transmission electron microscopy. The TEM images and selected area diffraction pattern of undoped TiO_2, Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 nanomaterials is as depicted in Fig. 4 a-i. The TEM mapping images of all these materials showing various sized nanomaterials ranging from 17 to 40 nm nanoscale, justifying the crystallite size obtained from XRD data. In addition to that nearly all TEM images depicting the crystal lattice of undoped and doped TiO_2 material as tetragonal anatase crystal lattice. The bright and sharp diffracted pattern in every SAED image of undoped and doped TiO_2 implying the good crystallinity of prepared materials. The SAED pattern is in good agreement with the XRD pattern obtained for undoped and doped TiO_2 nanomaterial.

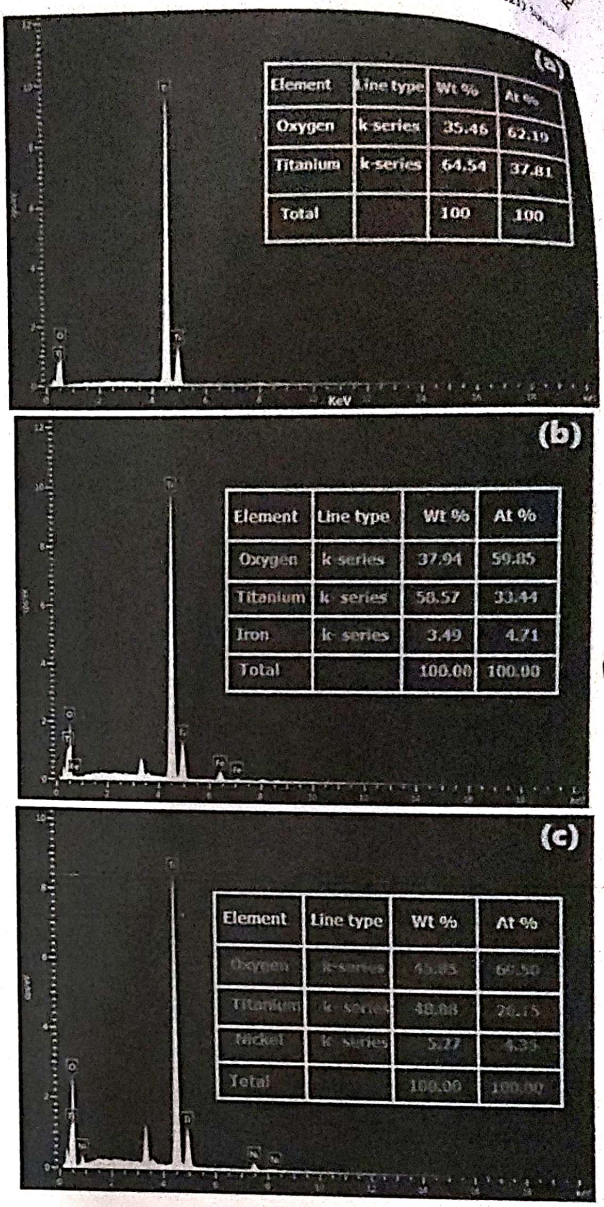

Fig. 3. (a) EDS spectrum of undoped TiO_2 thick films, (b) EDS spectrum of Fe^{3+}/TiO_2 thick films, (c) EDS spectrum of Ni^{2+}/TiO_2 thick films.

2.5. Brunauer-Emmett-Teller (BET) study

All the three screen print fabricated film sensors were investigated by Brunauer-Emmett-Teller (BET) study to know surface area of the prepared material by nitrogen adsorption-desorption experiment. The gas sensing is an adsorption phenomenon, the gas molecules which can be recognized as adsorbate entities, while film sensors acts as adsorbent species, hence to happen this mechanism more dynamic the appropriate surface area is necessitated, for effective sensor fabrication. Thus, it is exceptionally influential to investigate the surface area of the prepared sensor material. From this experiment the inherent surface area and composed surface area can be easily compared. Due to doping of the transition metals Fe and Ni within the crystal lattice of TiO_2, the surface area is found to be expanded in doped TiO_2. The surface area, pore volume, pore diameter and correlation coefficient values are as depicted

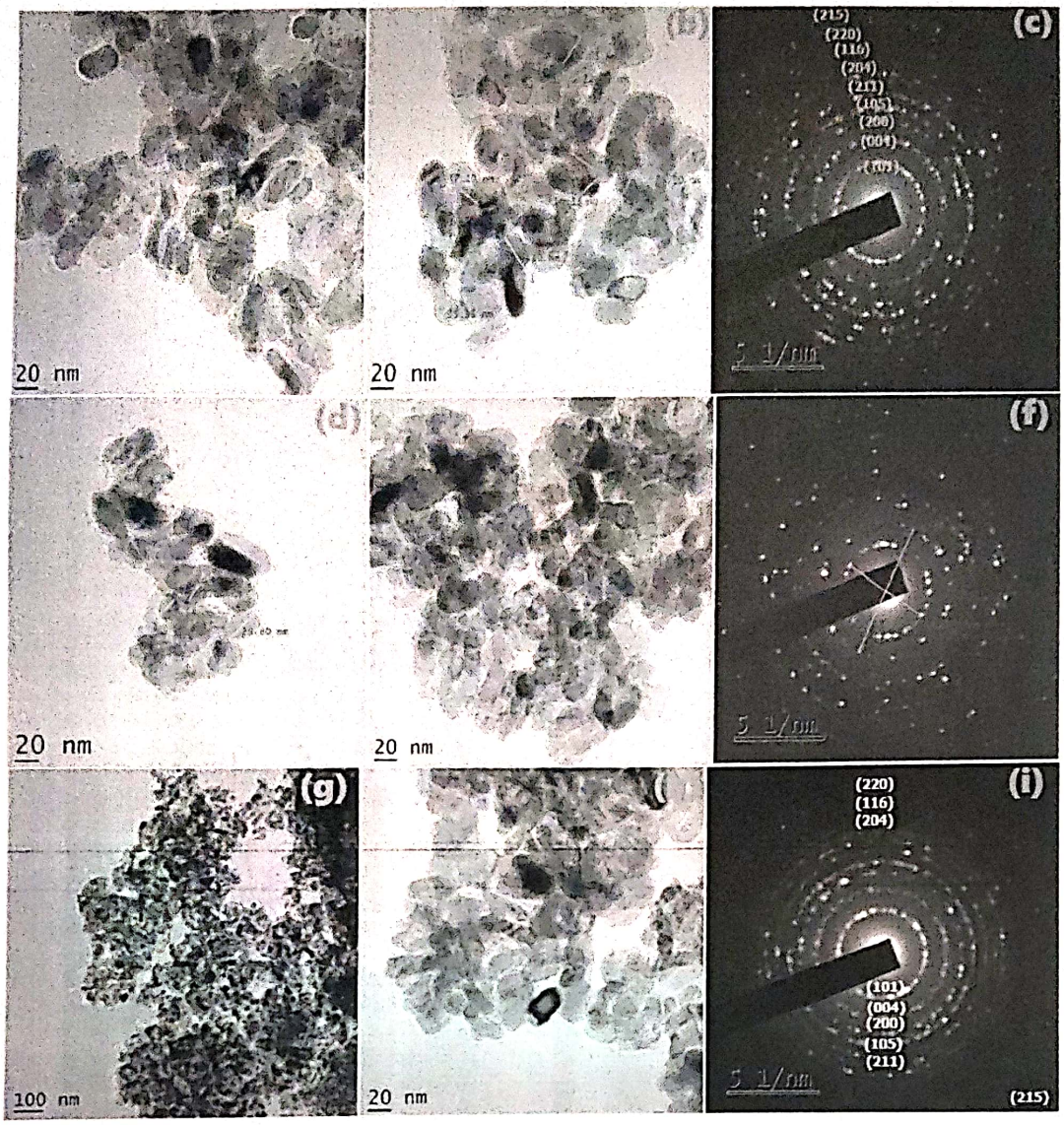

Fig. 4. (a,b) HR-TEM images of undoped TiO_2 thik films, (c) SAED pattern undoped TiO_2 thick films (d,e) HR-TEM images of Fe^{3+}/TiO_2 thick films, (f) SAED pattern Fe^{3+}/TiO_2 thick films, (g,h) HR-TEM images of Ni^{2+}/TiO_2 thick films, (i) SAED pattern of Ni^{2+}/TiO_2 thick films.

in Table 1. From the data presented in Table 1 it can easily see that Fe^{3+} doped TiO_2 material has improved surface area 83.10 m^2/g, due to small crystallite size, and strong agglomeration of nanoparticles giving good porosity to this material. On the other hand the undoped TiO_2 has inherent surface area of 67.34 m^2/g and slight escalated surface can be seen for Ni^{2+} doped TiO_2 material. Overall, the surface area is found to be improved for doped material and hence good gas response properties have been recorded for the prepared sensors explained in the fourth sections. From the current examination of BET study, it very well may be reasoned that out of six isotherm adsorption classifications as per BDDT framework, the adsorption bends as referenced in Fig. 5 a-c has a place with type IV of BDDT classes of adsorption isotherm, which establishes an distinct permeable material.

2.6. X-ray photoelectron (XPS) study

The XPS survey spectrum and individual atom binding energy curves are as represented in Figs. 6 and 7 for Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 respectively. The XPS spectrum represents the element composition, intrinsic characteristics, specific biding energies and chemical states of analyzed elements. The spectrums are calibrated with the standard C–1S peak sharp at 284.20 eV. The survey spectrum presented in Fig. 6-a and 7-a representing the compiled spectrum at specific binding energies for a particular element. In both the figures the titanium is resoluted at characteristics 458 eV, while the iron is sharply resoluted at 708 eV, while Ni is visible at 854 eV. The binding energy curves obtained in the present investigation are in good agreement with the experimental data.

2.7. Gas sensing study of undoped TiO_2 and modified TiO_2 thick film sensors

The fabricated thick film sensors were investigated for gas sensing performance for selected gases such as CO_2, SO_2, and NO_2 gases. The gas sensing study was carried using a assembled gas sensing device as depicted in Fig. 8. The electric resistance in the presence of air (Ra) and resistance in the presence of gas (Rg) accorss the film sensors recorded for the selected gases such as CO_2, SO_2, and NO_2 gases. There are several reports have been reported for TiO_2 sensor for ethanol, acetone,

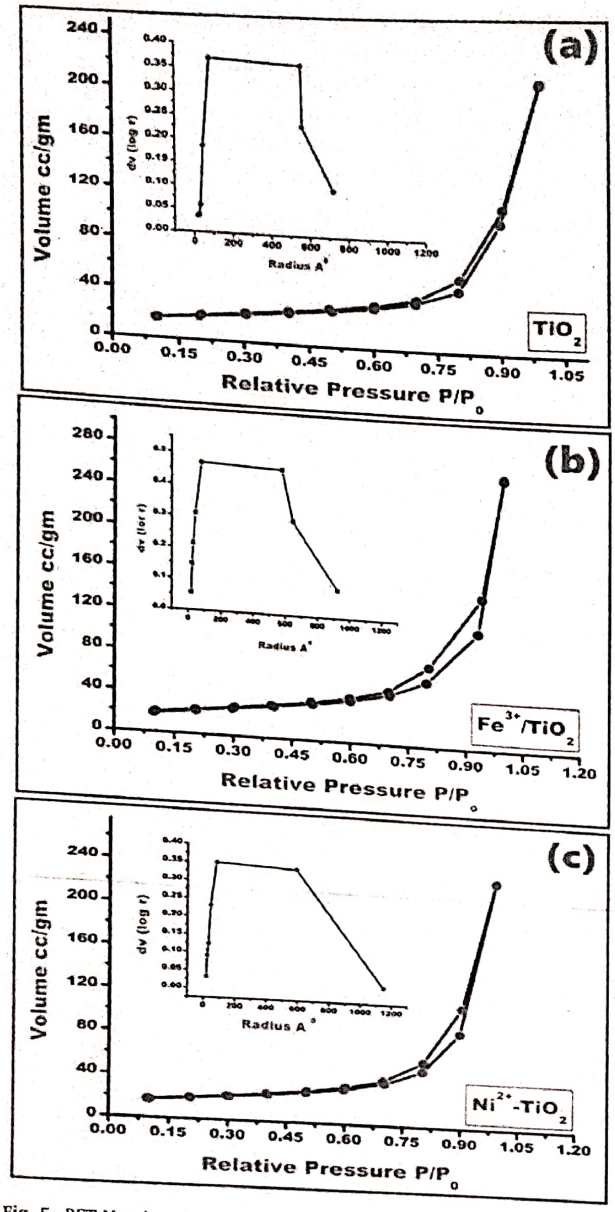

Fig. 5. BET N_2 adsorption-desorption curves and BJH pore distribution for (a) undoped TiO_2 thick film sensor b) Fe^{3-} modified TiO_2 thick film sensor, (c) Ni^{2+} modified TiO_2 thick film sensor.

methanol, H_2, H_2S etc. In the present research, we switched our attention to get gas sensing response from CO_2, SO_2, and NO_2 gases. Since, all these gases are recognized to be very toxic at their threshold limit and these gases are the main air pollutant in the atmosphere. These gases are majorly released from automobiles and as by-products emissions of several industries. Hence the undoped TiO_2, Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 sensors were utilized for these air pollutants and their comparative results have been summarized in the present research. The output resistance of the screen printed undoped TiO_2 and doped TiO_2 thick films was measured by half bridge technique. The film sensor was hold close to the base at which alumel-chromel thermocouple was fixed to perceive the temperature of the film sensor. Temperature perceived by Al–Cr thermocouple was measurably noticeable by means of temperature recorder. In the gas sensing test the desire gas concentration in ppm level was permitted to bring by means of inlet pipe into the centre of glass chamber of gas sensing unit shown in Fig. 8. The present gas by means of line valve is ended close to film sensor area with the end goal that the contact between sensor material and adsorbate gas will be most extreme. The decided DC voltage was given to the circuit. The film sensor resistance was processed through output voltage computerized multimeter model number CIE classic 5175. For each run gas fixation was embedded inside the glass arch, while gas residue was contemplative by providing the fixed measure of temperature by lifting the glass chamber. The electrical resistance of the thick films within the sight of air (Ra), just as within the sight of gas (Rg) was estimated to calculate the gas response or sensitivity(S) given by equation (2).

$$\%\,S = \frac{Ra - Rg}{Ra} \times 100 \qquad (2)$$

2.8. Gas sensing properties for prepared sensors

The gas sensing properties of undoped TiO_2, Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 thick film sensors were tested for CO_2, NO_2, and SO_2 gas vapors. Since gas sensing response is strongly influence in presence of temperature. Hence the gas sensing study for fabricated sensors was investigated from the temperature range of 300–30 ^{0}C at cooling cycle with the interval of 30 ^{0}C. In order to get the optimum response for each sensor for particular gas the each optimum temperature was investigated. The gas sensing curves for tested gases CO_2, NO_2, and SO_2 at undoped TiO_2, Fe^{3+} doped TiO_2 and Ni^{2+} doped TiO_2 thick film sensors is can be seen from the Fig. 9 a-c. From the gas sensing experiment it was observed that the Fe^{3+} and Ni^{2+} modified TiO_2 sensor is quite sensitive to the SO_2 vapors. while undoped TiO_2 sensor showed high response to nitrogen dioxide (NO_2) gas vapors. The undoped TiO_2 showed response to CO_2 gas at 210 ^{0} C with 55.48%, while for NO_2 gas the response was recorded at 300 ^{0}C with 59.20% response and for SO_2 gas the undoped TiO_2 showed 52.47% gas response at 210 ^{0} C. While in case of Fe^{3+} doped TiO_2 the highest response was recorded for SO_2 gas vapors. at 210 ^{0}C with 81.56%, the gas response showed by NO_2 gas at 120 ^{0}C with 71.56% response and CO_2 gas for iron-modified TiO_2 sensor showed 57.16% gas response at 150 ^{0}C. Finally, the Ni^{2+} modified TiO_2 sensor was tested for selected gases CO_2, NO_2 and SO_2 gases. The sensor sowed 55.12% response for CO_2 gas at 180 ^{0} C, while for NO_2 vapors 65.23% response at 150 ^{0}C was recorded. While for SO_2 gas the high response at 240 ^{0}C with 69.71% was recorded.

Since, the sensors were tested for CO_2, NO_2 and SO_2 gases, out of that the Fe^{3+} doped TiO_2 sensor showed good response against NO_2 and SO_2 gases. Hence these gases were tested for high gas concentration up to 1000 ppm. The Fig. 10 a-b shows the gas response from 100 to 1000 ppm and inset figure i-ii showing the linear relationship for the SO_2 and NO_2 gases for 10–100 ppm concentration. Fig. 10 a-b shows the steady increase in gas response for both SO_2 and NO_2 gases from 100 to 500 ppm gas concentrations. While the gas response after 500 ppm (600 ppm onwards) sensor did not showed the steady gas response pattern, instead a slight declined in the gas response is observed. This declined gas response change after 600 ppm–1000 ppm attributed to the sensor Fe^{3+} doped TiO_2 tended to saturation point moderately. The sensor Fe^{3+} doped TiO_2 showed good response for SO_2 and NO_2 gases at 500 gas concentration the probable reason attributed for the observation is enhanced surface area for Fe^{3+} doped TiO_2 sensor (83.81 m^2/g) in contrast to the Ni^{2+} doped TiO_2 sensor and undoped TiO_2 sensor (67.70 m^2/g and 67.34 m^2/g respectively). The BET data is represented in Table 1 from which the surface area and pore volume, pore radius can be compared for all the prepared sensors. The improved surface area leads to enhance the adsorption phenomenon for the gas sensors. Since, the gas sensor is a surface phenomenon; the adsorbate gas molecules and adsorbent sensor will utilize more surface matrix to get effective chemisorption or physisorption properties. Due to which the gas sensing properties will ultimately intensify. Thus, Fe^{3+} doped TiO_2 sensor showed a good response over other prepared sensors. Fig. 11 a-c showing the % gas selectivity for prepared sensors. All the prepared sensors are found to be highly selective for SO_2 gas vapors. The selectivity of the gases was calculated using equation (3).

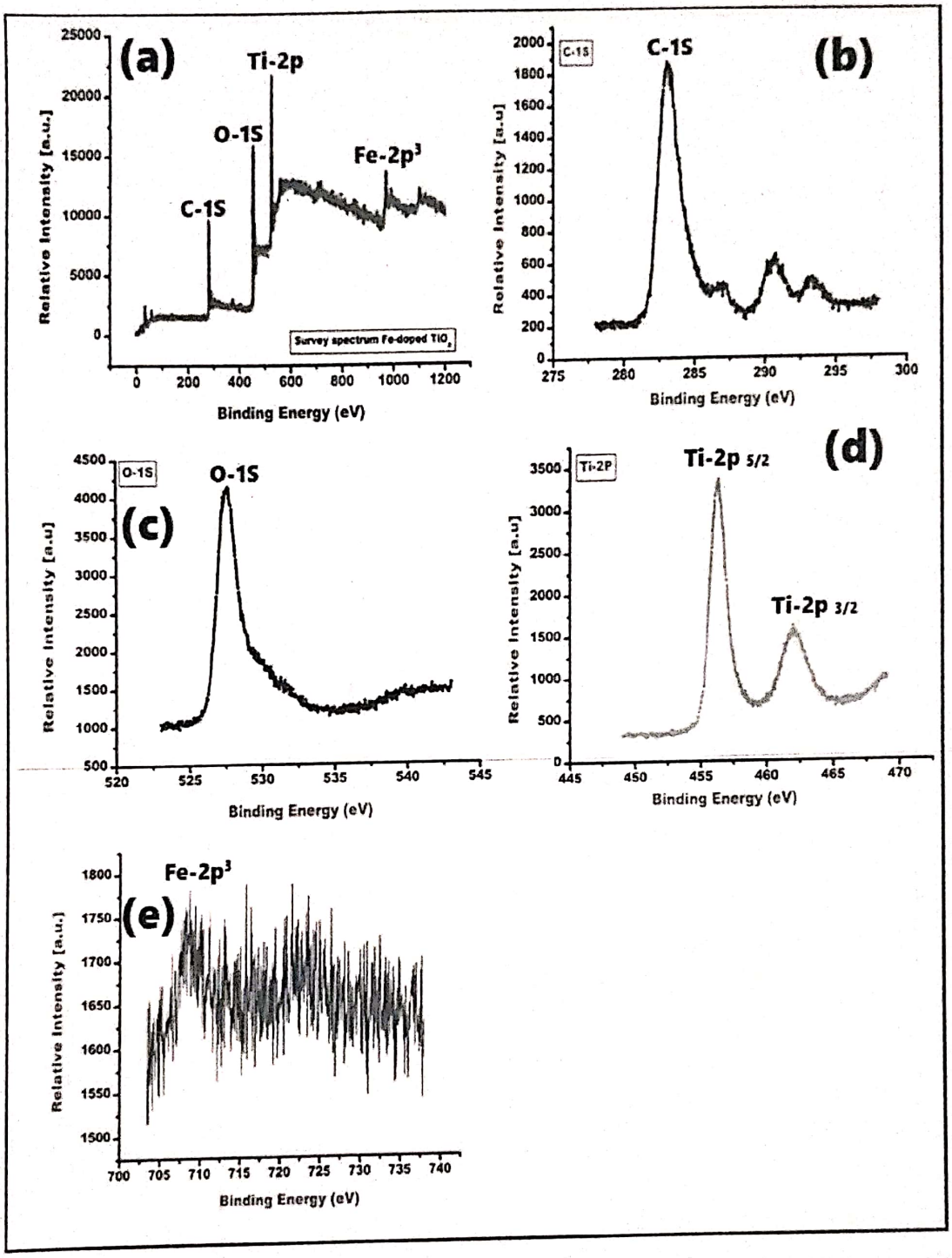

Fig. 6. (a) XPS Survey spectrum of Fe^{3+} modified TiO_2 thick films, (b) C-binding energy peak, (c) O- binding energy peak, (d) Ti- binding energy peak, (e) Fe-binding energy peak.

$$\% \text{ Selectivity} = \frac{S \text{ (target gas)}}{S \text{ (high responding gas)}} \times 100 \quad (3)$$

2.9. % selectivity of tested gases for undoped and Fe^{3+} and Ni^{2+} doped titanium oxide thick film sensor

2.10. Response and recovery of modified titanium oxide thick film sensor

Response and recovery are important parameters for designing an effective gas sensor. The response and recovery parameters give reliability regarding the effective response time and recovery parameters by the sensor at particular gas concentration and temperature. Here the Ni^{2+} modified TiO_2 and Fe^{3+} modified TiO_2 sensors utilized for response recovery parameters. Initially, both these sensors were utilized for SO_2,

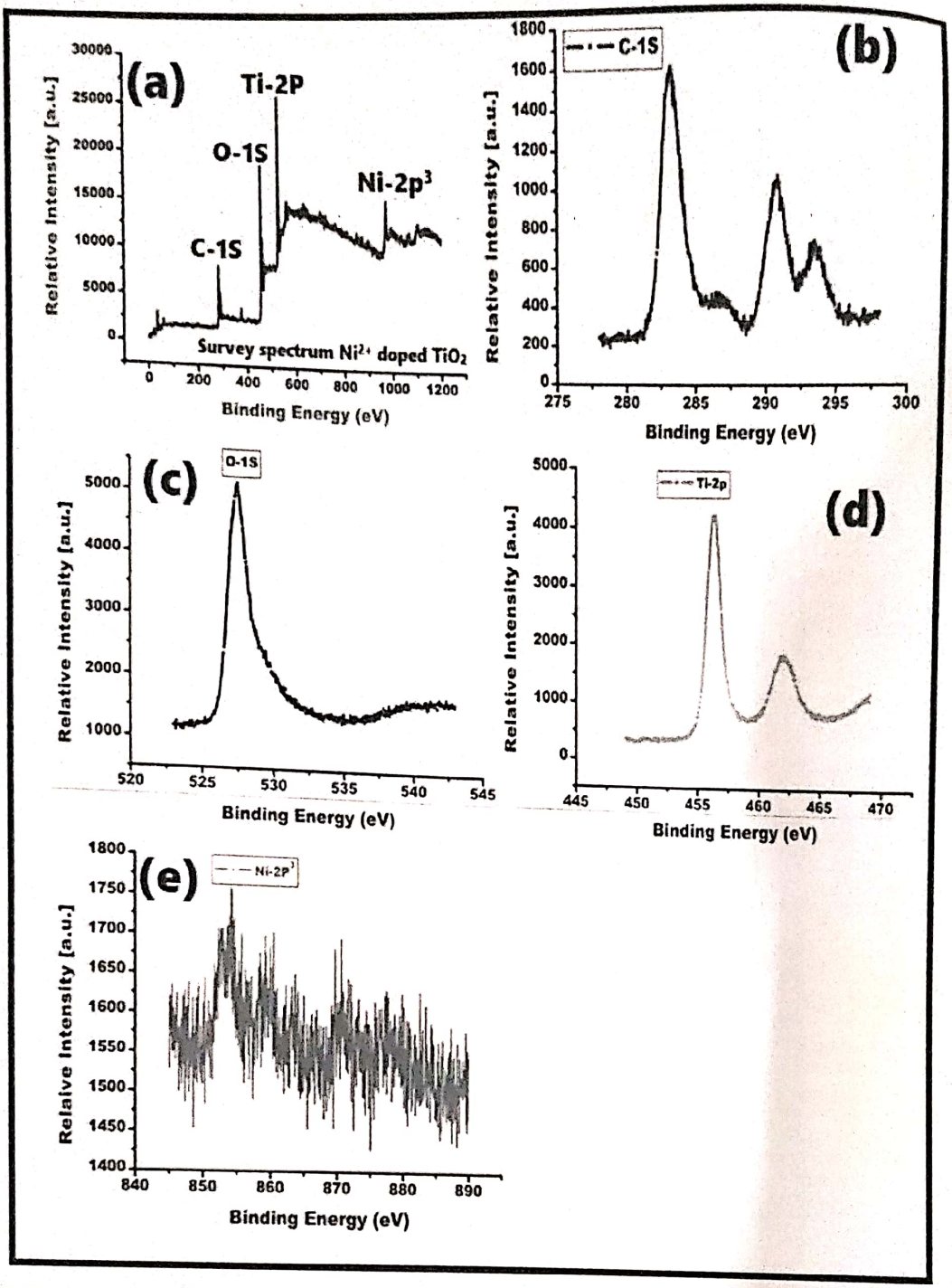

Fig. 7. (a) XPS Survey spectrum of Ni^{2+} modified TiO_2 thick films, (b) C-binding energy peak, (c) O- binding energy peak, (d) Ti- binding energy peak, (e) Ni-binding energy peak.

NO_2 and CO_2 gases, out of which SO_2 and NO_2 gas vapors are observed to be more sensitive for both Ni^{2+} modified TiO_2 and Fe^{3+} modified TiO_2 sensors. The response and recovery properties of both these sensors are as depicted in Fig. 12 a-d. From figure it can be seen that Fe^{3+} modified TiO_2 sensor has rapid response and recovery for SO_2, NO_2 gases. The response time of Fe^{3+} modified TiO_2 for SO_2 was 12 s and recovery was 30 s. Similarly, response time of Fe^{3+} modified TiO_2 for NO_2 gas vapors was 22 s and recovery was 34 s. At the same time the Ni^{2+} modified TiO_2 sensor was also investigated for same gases. Here, the response time for SO_2 gas at Ni^{2+} modified TiO_2 sensor was observed to be 18 s and recovery time was 52 s. While the response time for NO_2 gas vapors was found to be 22 s and recovery time was 36 s. The improved response and recovery time for Fe^{3+} modified TiO_2 can be attributed to enhance surface leads to improve more redox characteristics over the surface sensor. Since gas response is redox process associated with the active species like oxy ions O_2^-, O^-, or O_2^-. Large surface area ultimately attracts more active species over the surface and hence more rapid chemisorption reactions leads to generate the output signal at the rapid time. Hence, Fe^{3+}

Table 1
BET surface area, pore volume and pore diameter of Undoped TiO_2, Fe^{3+} modified TiO_2 film sensor, Ni^{2+} modified TiO_2 film sensor.

Prepared Material	Surface Area (m^2/g)	Pore volume (cc/g)	Pore radius (Å)	R^2
Undoped TiO_2 film sensor	67.349	0.355	80.54	0.9881
Fe^{3+} modified TiO_2 film sensor	83.810	0.381	85.12	0.9999
Ni^{2+} modified TiO_2 film sensor	67.701	0.326	79.48	0.9850

modified TiO_2 sensor has good response and recovery time for the tested SO_2, NO_2 gases.

2.11. Reusability parameters and stability of prepared sensors for tested gases

The prepared sensors Ni^{2+} doped TiO_2 and Fe^{3+} doped TiO_2 sensors were investigated for high responding gases SO_2 and NO_2 at the time interval of 15 days in four runs. The recycling performance is a prime parameter to get the reproducible sensing response for the particular gases at the stipulated time period. The Fig. 13 a-d given below showing the reusability results for prepared sensors at SO_2 and NO_2 gases. In the first run for prepared sensor Fe^{3+} doped TiO_2 sensor at SO_2 gas 81.56% response was recorded, now at the time interval of 15 days i.e in the second run for same gas 80.72%, in the third run 79.20% and in the final run after 60 days 79.10% response was recorded for the same sensor. The Fe^{3+} doped TiO_2 sensor was also utilized in the reusability experiment for NO_2 gas vapors at 500 ppm concentration. In the first run 69.72% response was recorded, simultaneously from interval of 15–60 days i.e. second to fourth run the response was 68.12%, 67.30% and 66.90% for second, third and fourth run respectively. The another sensor Ni^{2+} doped TiO_2 was also utilized for same test, here for SO_2 gas vapors in the first run 71.55% gas response was recorded. Simultaneously, in the second, third and fourth run with the time interval of 30, 45 and 60 days the % response of 70.80%, 69.78% and 68.72% was recorded respectively. The same sensor Ni^{2+} doped TiO_2 was also utilized for NO_2 gas vapors with similar experimental conditions. Here, for NO_2 vapors in the first run 65.24% gas response was recorded. While in the second, third and fourth run 64.13%, 62.80% and 61.13% gas response was recorded respectively. The observation regarding the decline in gas response after successful four run for tested sensors could be assign to the reduction in the surface activity of the sensors. When, these sensors continuously subjected for the reusability performance it was observed that overlying surface activity found to be declined due to exposure of gas vapors in each run leads to lower the adsorption properties over the sensor surface. Hence, slight decline sensitivity response was noticed throughout the recycling experiment.

2.12. Comparison of the prepared Fe^{3+} modified TiO_2 sensor

Since, there is considerable work has been reported over the TiO_2 material for various applications. Although TiO_2 is versatile material, popularly it is being used in Photocatalysis experiments. The TiO_2 based materials are also reported as effective gas sensors for ethanol, acetaldehyde, hydrogen, H_2S, VOCs, ammonia etc. But, very rare reports are available for SO_2, NO_2 and CO_2 gases. In the present research transition metals Ni^{2+}, Fe^{3+} modified TiO_2 sensors are showed good response for SO_2, NO_2 gases. The gas sensing properties of modified TiO_2 based sensors are compared with the various reported sensors (Table 2). Sulphur dioxide is one of the major pollutants present in the atmosphere due industrial air discharge. There are many fatal diseases reported due to consumption of high concentration of SO_2, hence to monitor its

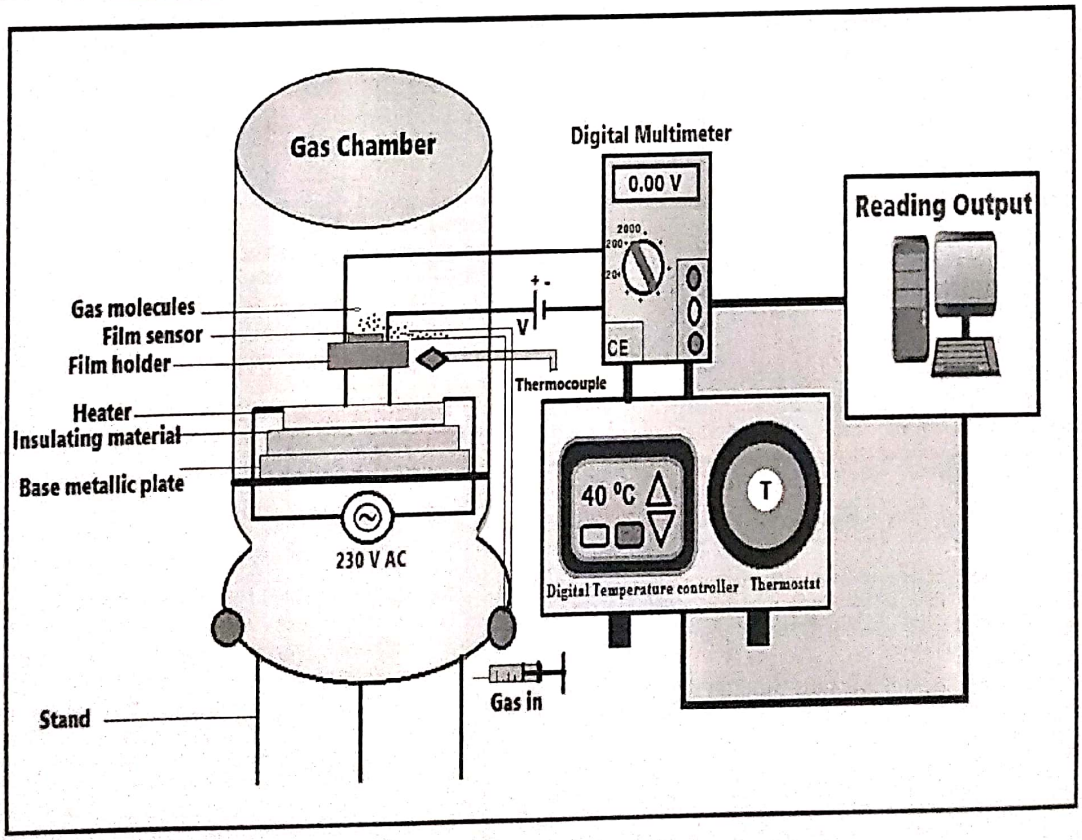

Fig. 8. Block diagram for gas sensing study used in present research.

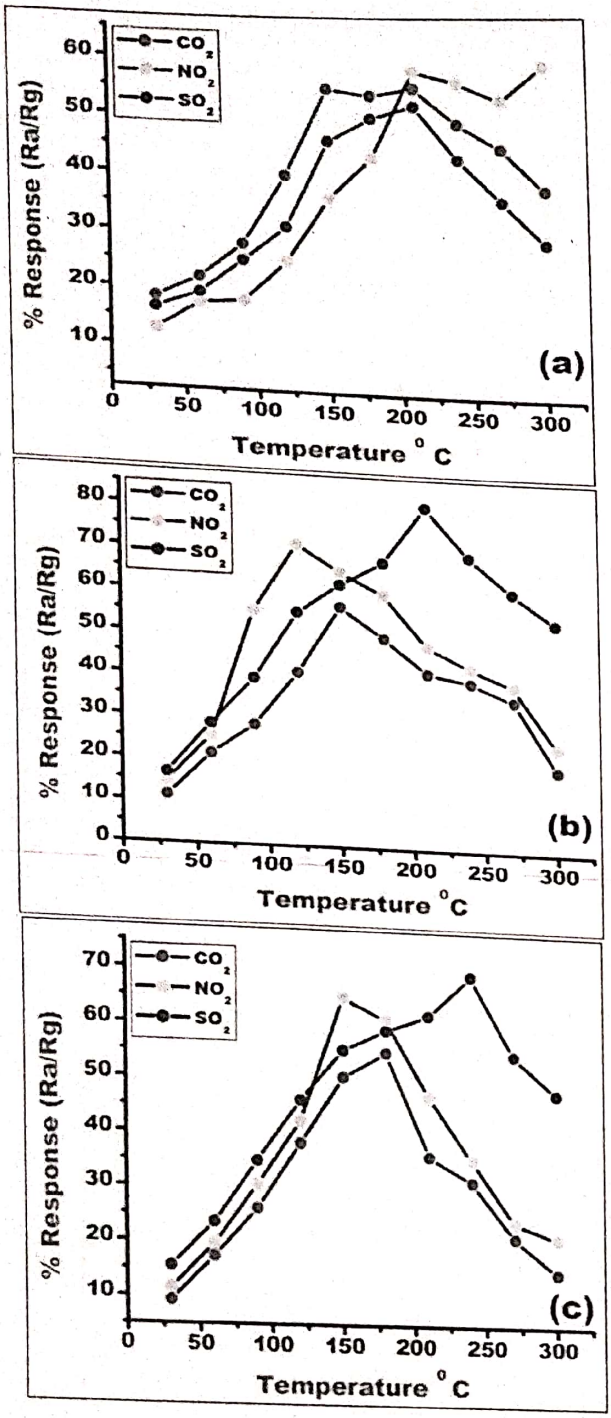

Fig. 9. (a) Gas response of tested gases at optimum temperature for undoped TiO_2 (b) Gas response of tested gases at optimum temperature for Fe^{3+}/TiO_2 (c) Gas response of tested gases at optimum temperature for Ni^{2+}/TiO_2.

concentration by various sensors is very prime step to minimise the fatal injuries and incidents.

2.13. Mechanism of modified TiO_2 sensor for SO_2 gas vapors

The surface oxygen vacancies present over the sensor surface are the dissociated active species of molecular oxygen. The reactive oxygen species are O_2^-, O_2^{2-}, O^-, adsorbed over the sensor Fe^{3+} doped TiO_2 leads to generate the electron depletion layer over the sensor surface. The mechanism of SO_2 adsorption by modified by TiO_2 is well described in the literature [80]. As per the well known facts SO_2 vapors may be generated due to reaction between SO_2 and reactive oxygen species represented in equation (4) and (5)

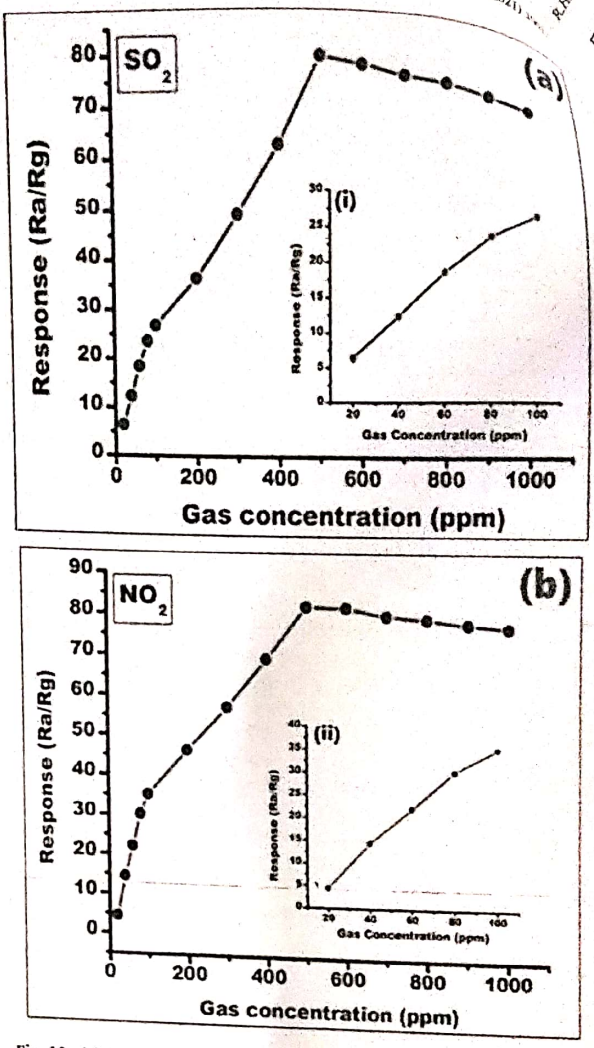

Fig. 10. (a) % gas response for Fe^{3+} doped TiO_2 gas sensor for SO_2 gas vapors at 10–1000 ppm gas concentration (b) % gas response for Fe^{3+} doped TiO_2 gas sensor for NO_2 gas vapors at 10–1000 ppm gas concentration, i, ii inset diagrams showing linear relationship for SO_2 and NO_2 gases at 10–100 ppm gas concentration for Fe^{3+} doped TiO_2 gas sensor.

$$SO_2 + O^x + ne^- \rightarrow SO_{2+x}\ (X = 1 \text{ or } 2) \quad (4)$$

$$x.SO_2 \leftrightarrow (x\text{-}1)\ SO + SO_{1+x}\ (x = 2 \text{ or } 3)\ \text{(disproportion)} \quad (5)$$

The elevated potential barrier, formed near the grain boundary of Fe^{3+}/TiO_2 resulted into enhanced resistance for Fe^{3+}/TiO_2 sensor. The initiation of the SO_2 gas sensor mechanism is introduced due to swapping of electrical conductance of Fe^{3+}/TiO_2 sensor due chemical reaction kinetics of adsorbed O_2 molecules on the sensor surface and available SO_2 gas vapors. The atmospheric oxygen get adsorbed over the Fe^{3+}/TiO_2 sensor surface and grabs the electron available near the conduction band of Fe^{3+}/TiO_2 sensor. Likewise the space charge layer is framed over sensor exterior and in the air, leads to generate potential barrier that hold up the free electrons flowing and thus the resistance reading of Fe^{3+}/TiO_2 sensor increases. Since TiO_2 material is semiconducting in nature,

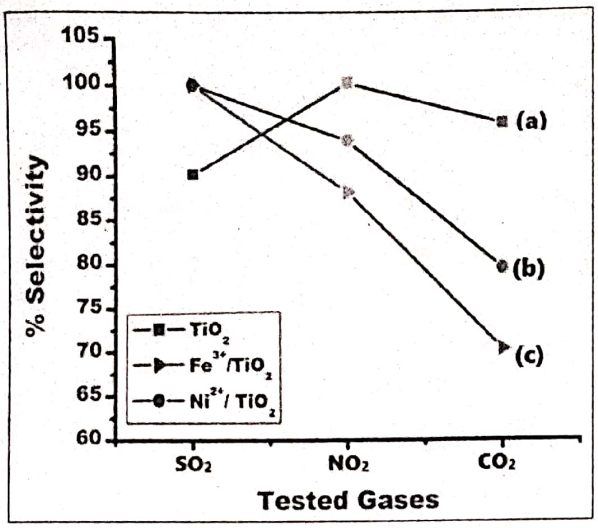

Fig. 11. (a) % selectivity of undoped TiO_2 (b) % selectivity of Ni^{2+} doped TiO_2 (c) % selectivity of Fe^{3+} doped TiO_2.

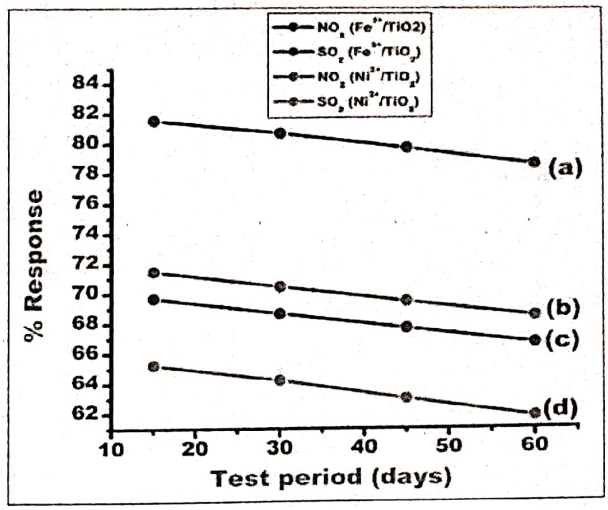

Fig. 13. (a, b) Reusability test for Fe^{3+} doped TiO_2 sensor at SO_2 and NO_2 gases, (c, d) Reusability test for Ni^{2+} doped TiO_2 sensor. at SO_2 and NO_2 gases.

the resistance value of the sensor declined with the rise of temperature. Although, the enhanced resistance around 210 ^{0} C may be due to the result of conversion of O_2^- into atomic oxygen $2O^-$ as well as large free electron capture. The sulphur dioxide gas molecules succeeding the common effect between Fe^{3+}/TiO_2 sensor and adsorbed oxygen species discharge the trapped charge carriers. Whenever oxygen vacancies comes into Fe^{3+}/TiO_2 lattice, they blend the reaction of available electrons, O_2

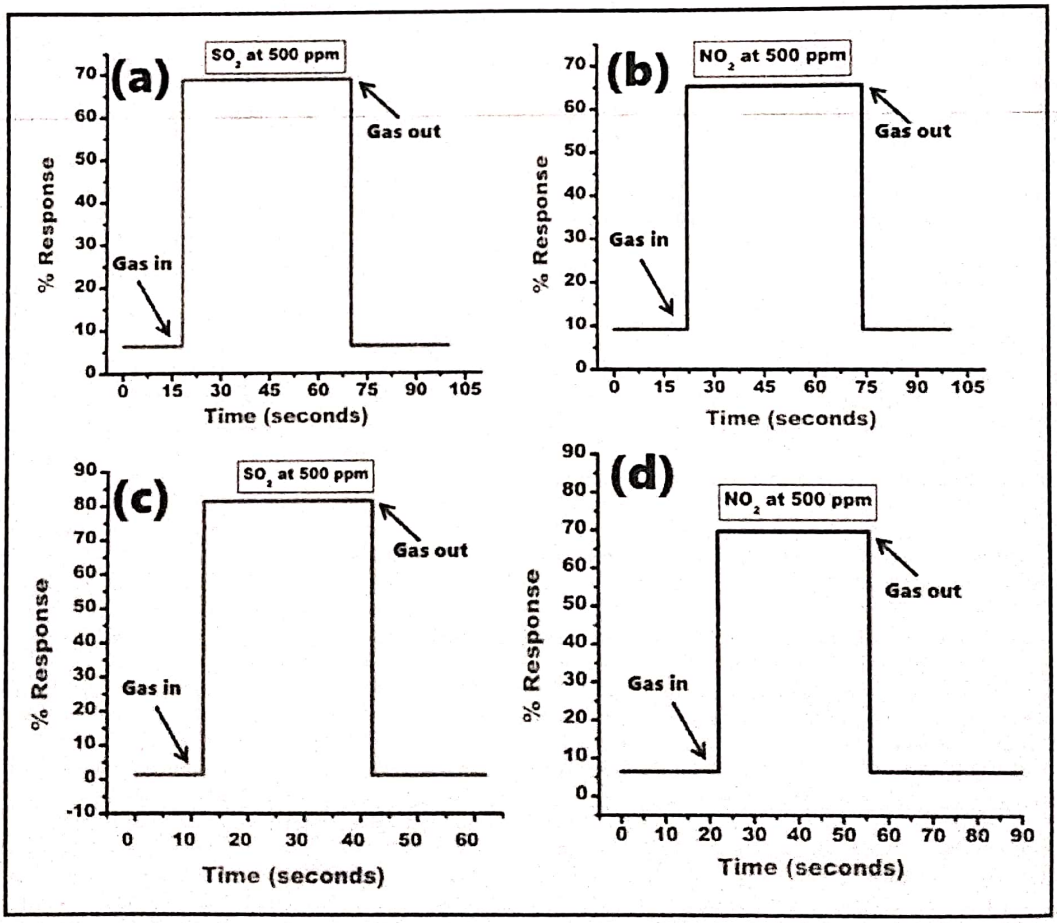

Fig. 12. (a, b) Response and recovery curves for SO_2, NO_2 gases for Ni^{2+} doped TiO_2 sensor (c, d) Response and recovery curves for SO_2, NO_2 gases for Fe^{3+} doped TiO_2 sensor.

Table 2
Comparative studies of SO_2 for modified TiO_2 sensor and reported sensors.

Sensor	Method of Fabrication	Type of sensor	Sensing Temp. (°C)	Gas in ppm (SO_2)	Reported Sensitivity (%)	Reference
NiO–SnO_2	Spin coating	Thin Film	180	50	8.3	[73]
Ni–MoS_2	Hydrothermal	Thin film	RT	250	7.4	[74]
Li_3PO_4–Li_2SiO_3	sputtering	Thin film	400	100	70.19	[75]
GO-ZnO	Photolithography	Thin film	RT	100	5.45	[76]
SnO_2	r-f diode sputtering	Thin film	180	500	56	[77]
WO_3	FET	Thin film	150	125	-	[78]
Nb– WO_3	Hydrothermal and Impregnation	Thick film	250	500	10.0	[79]
Fe^{3+} doped TiO_2	**Screen printing**	**Thick film**	**210**	**500**	**81.56**	**Present Work**

and ultimately motion of charge carriers declined and this causes the dwindle of surface space charge and responsible to enhance the response of sensor. In the present research the enhance surface area for Fe^{3+}/TiO_2 sensor is not the sole reason to enhance towards the SO_2 gas vapors in addition to that enhance surface O_2 vacancy is also contributes to the sensor response.

3. Materials and methods

The chemicals consumed in the present research work for the fabrication of titanium dioxide are purchased from sigma-Aldrich Mumbai. The chemicals used in the present research are used without any further process like purification etc. Chemicals used are titanium isopropoxide, Ferric nitrate, nickel nitrate, NaOH and deionized water.

3.1. Synthesis of undoped titanium dioxide nanoparticles by co-precipitation method (CPT method)

The titanium dioxide nanoparticles were prepared by cost effective co-precipitation method. For this synthesis titanium isopropoxide was used as a basic compound to fabricate the titanium dioxide nanoparticles. Initially, stoichiometric mole concentration (0.01 mol) of titanium isopropoxide was used to initiate the reaction. The calculated mole concentration of titanium source was added slowly (dropwise) to the 20 mL of deionized water. This water and titanium precursor mixture resulted to hydrolysis of the alkoxide and finally precipitated as hydrous titanium precursor. This solution then thoroughly mixed by constant stirring at low temperature of about 70–80 ^{0}C for nearly 40 min. The white precipitate of titanium hydroxide precursor was settled at the bottom of the beaker, which was separated by centrifugation method. The titanium precursor was centrifuged at 300 rpm for 300 s. The precipitate was washed with hot water and ethanol, and then dried in oven at 100 ^{0}C overnight. The dried titanium precursor powder was then subjected to calcination under muffle furnace at 450 ^{0}C nearly for 5 h. The titanium dioxide nanoparticles were recovered from muffle furnace for further use.

3.2. Synthesis of Fe^{3+} and Ni^{2+} titanium dioxide nanoparticles by co-precipitation method

For synthesis iron and nickel doped modified titanium dioxide nanoparticles the same method as explained in section 2.1 was followed. But, additionally 5% dopant concentration of each metal i.e., Fe^{3+} and Ni^{2+} salts were added to the solution of titanium isopropoxide in two separate beakers. The remaining same procedure was followed for the synthesis of Fe^{3+} and Ni^{2+} doped modified titanium dioxide nanoparticles.

3.3. Fabrication of thick films of undoped TiO_2 and 5% Fe^{3+}, titanium dioxide nanoparticles and 5% Ni^{2+} modified TiO_2 nanoparticles by screen printing strategy

The thick films of both the prepared nanomaterials viz. undoped titanium dioxide and Fe^{3+}, Ni^{2+} doped modified titanium dioxide nanoparticles were processed further to prepare thick films. These both prepared nanoparticles were considered as inorganic part, while the binders utilized to adhere the nanoparticles on the films were organic compounds namely butyl carbitol acetate (BCA) and ethyl cellulose (EC). Here the caution was taken that the inorganic to organic proportions should to 70: 30 respectively. Both these prepared nanoparticles of undoped titanium dioxide, Fe^{3+} doped titanium dioxide and Ni^{2+} doped modified titanium dioxide were finely mixed one by one separately into mortar and pestle for obtaining more fine particles and better adherness over the glass films. Then, separately BCA and ethyl cellulose were dropped into each mixture one by one, the paste of both these materials prepared separate. Then, this prepared paste of undoped and doped titanium oxide nanoparticles was applied over the glass substrate by means photolithographic technique with the aid of screen-printing apparatus on the glass substrate of dimensions 1 × 2 cm. The prepared films then dried under IR lamp for 40 min, and then these all films kept in muffle furnace at 400 ^{0}C for 3 h. The prepared film sensor then utilized further for next investigation.

3.4. Thickness measurement of the films

The thickness over the films was enumerated by utilizing equation (6). By computations of equation (2) the thickness of the undoped TiO_2 film sensor was found to be 6.125 um (6125 nm). While, the surface thickness of Fe^{3+} doped TiO_2 sensor was observed to be 5.314 um (5314 nm) and thickness of Ni^{2+} doped TiO_2 sensor film sensor was observed to be 5.623 um (5623 nm). As per the results obtained, the thickness of the prepared sensor was observed in the thick region.

$$t = \Delta M / A \times \rho \quad (6)$$

ΔM = Mass difference of the film sensor before and after deposition, ρ = Composite density of undoped titanium oxide and Fe^{3+}, Ni^{2+} doped titanium dioxide (TiO_2), A = Area of the films (1*2 cm).

4. Conclusions

The undoped TiO_2 and 5% Fe^{3+} modified TiO_2 and Ni^{2+} modified TiO_2 were prepared by low cost co-precipitation (CPT) route. The thick film sensors bare TiO_2, 5% Fe^{3+} modified TiO_2 and 5% Ni^{2+} modified TiO_2 were fabricated by screen printing strategy. The transition metals Fe^{3+}, Ni^{2+} are successfully doped to give enhanced surface area of 83.10 m^2/g and 67.70 m^2/g respectively. The XPS results also confirm the surface doping and concise chemical composition of Fe^{3+}, Ni^{2+} modified TiO_2 sensor. The XRD data confirms the anatase phase TiO_2 nanoparticles. The TEM also justifies the prepared the TiO_2 material belongs to anatase crystal lattice. All the prepared sensors were utilized for gas sensing of common environmental pollutant gases such as SO_2, NO_2, and CO_2. The Fe^{3+} modified TiO_2 sensor was found to be more sensitive towards SO_2 gas vapors at 500 ppm concentration and 210 ^{0}C temperature. While Ni^{2+} modified TiO_2 sensor was also found to be good sensitive towards SO_2 gas vapors at 500 ppm gas concentration with 69.71% response at 240 ^{0}C. Both these sensors also found to be moderately sensitive towards NO_2 and CO_2 vapors. The Fe^{3+} modified TiO_2

sensor was tested for response and recovery, the sensor showed rapid response and recovery for the tested gases SO_2 and NO_2. The reusability and stability test was conducted in four runs with time interval of 15 days for Fe^{3+} and Ni^{2+} modified TiO_2 sensor. From the results it can be concluded that the sensor is reliable and showed long-time stability for gas sensing response of SO_2 and NO_2 vapors.

Conflicts of interest

The authors declare no conflict of interest for the present research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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MOU Activity Report

Department of Chemistry
M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik

MOU Activity With

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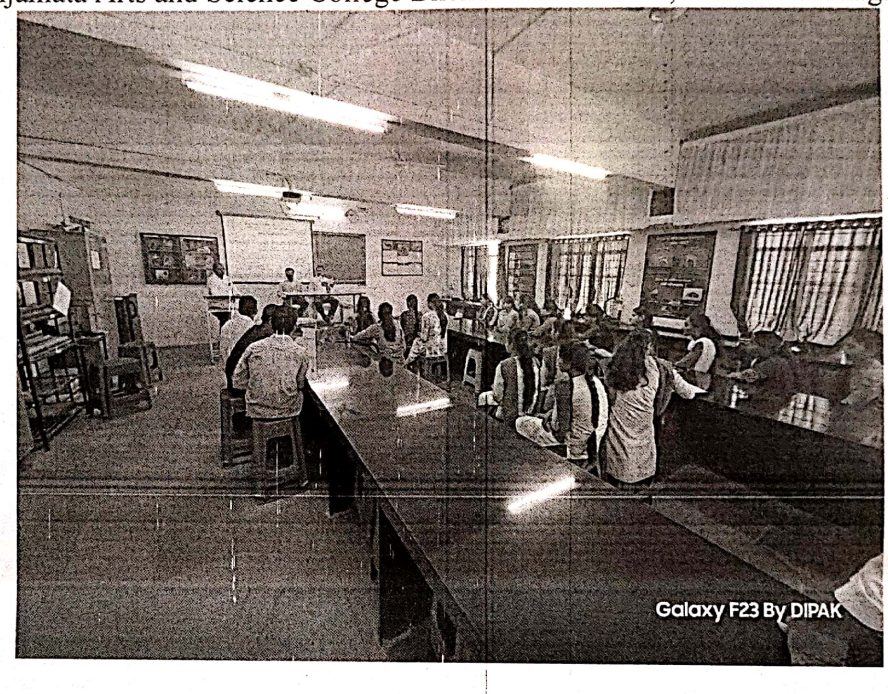

Department of Chemistry, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organized as Guest lecture on "**Brief Introduction in Periodic Table**" during 15th February, 2021. In this program Dr.D.T.Tayde, Assistant Professor & Head of Department of Chemistry, Sahyadri Shikshan Mandal Dindori Sanchalit, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali, delivered a lecture on "Brief Introduction in Periodic Table".In his lecture he discuss with students about four blocks of periodic table such as s, p, d and f. Importance of periodic table in chemistry. There is 30 more students take advantage of this interactive talk.

M.J.M.A.C.&S. College Karajali Tal.Peth. Dist.Nashik

Principal
M.J.M. Arts, Commerce &
Science College Karajali,
Tal.Peth. Dist.Nashik

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Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
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Transition Metals Ni^{2+}, Fe^{3+} Incorporated Modified ZnO Thick Film Sensors to Monitor the Environmental and Industrial Pollutant Gases

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ABSTRACT

Zinc oxide is known as multifaceted material due to its special physical and chemical properties. Present research deals with the fabrication of undoped ZnO, 1.5% Fe^{3+} doped ZnO, and 1.5% Ni^{2+} doped ZnO nanoparticles by low-cost co-precipitation method. These prepared materials were utilized to prepare thick film sensors by employing a screen printing technique. The structural confirmations of these materials were performed by various nano-characterization techniques. The structural properties were investigated by XRD to confirm the nanoscale ZnO as well as the average crystal dimensions. The surface morphological properties of undoped and modified ZnO were analyzed by SEM and TEM methods. The average volume pores over prepared materials and surface area were concluded from the N^2 adsorption-desorption experiment (BET analysis). The Fe^{3+} doped ZnO has the highest surface area among all the prepared sensors i.e. 23.55 m^2/g. The Fe^{3+} doped ZnO and Ni^{2+} ZnO nanomaterials were observed to show declined band gaps in comparison to the undoped ZnO material. All the prepared sensors were employed for the gas sensing study of gases like NH_3, LPG, formaldehyde vapors, toluene vapors, CO, CO_2, and NO_2. The CO_2 and NH_3 vapors found to be very sensitive towards Fe^{3+} doped ZnO with 76.62% and 76.58% sensitivity respectively. The Ni^{2+} doped ZnO sensor sensitivity for CO_2 and NH_3 was recorded as 71.20% and 70.23% respectively. The LPG, CH_2O, and toluene vapors' sensitivity was also studied for the modified ZnO sensor. Besides, modified ZnO utilized as a relative humidity sensor with an RH variation of 10-90%. The impedance versus humidity curves recorded for all sensors. The Fe^{3+} doped ZnO nanomaterial at 10 Hz was found to be an effective humidity sensor. The response and recovery were found to be very rapid in Fe^{3+} doped ZnO for NH_3, CO_2, NO_2, and LPG vapors.

Keywords: Modified ZnO sensor, CO_2, NO_2, NH_3 gas sensing, Humidity sensor, BET, TEM.

INTRODUCTION

Nanotechnology is a productive technology that has become standout in various scientific fields due to its wide range of applications[1-5]. Nanotechnology is diverse technology found to be very prominent in various fields of science and engineering technology. The amazing applications of nanomaterials are listed in various beneficial and scientific fields such as optoelectronics, gas sensing, batteries, solar cells, effluent treatment, organic synthesis and conversions, energy conversion, fuel technology, defense system, agriculture, medicinal, pharmaceutical sectors, biosensing, catalysis, water purification technology, adsorbent materials, electronics mechanical applications, etc.[6-26].

There is a huge increase in the pollution around the atmosphere due to increasing industrialization. There are plenty of side effects and health hazards due to the consumption of these toxic gases[27-30]. The environmental safety has become a prime important thing in recent times[31-33]. Many incidents have been reported regarding toxic gas leakage and their severe side effects[34]. Thus, toxic gases evolved by industries must be detected in their threshold limit value (TLV). Most of the reports have been issued about the detection of toxic vapors/gases by the use of various semiconducting bases sensors[35-37]. The semiconducting metal oxides (SMO) based sensors found to be very promising materials for the sensing purpose of various gases[38-40]. Although there are plenty of SMO based sensors that have been designed as gas sensors in the form of thick or thin films, the zinc oxide semiconducting sensor is the most intensively reported gas sensor for a wide range of gas sensing applications. There are many advantages for choosing ZnO based sensors such as low-cost synthesis methods, no toxicity, high thermal stability, excellent catalyst performance, porous nature, good surface area, reproducible results, etc. Many methods have been accounted for the synthesis of zinc oxide nanoparticles, such as co-precipitation, sol-gel, spray pyrolysis, chemical vapour deposition, mechanical, hydrothermal, ultra sonication, microwave techniques, etc.[41-48]. The properties like corrosion-resistivity, low electrical conductivity, antimicrobial activity, good heat resistance, mechanical stability, high catalytic activity, and its non-toxic nature make it unique amongst metal oxide nanoparticles.

Apart from sole semiconducting metal oxide as a sensing device, there are many new techniques by which a more useful sensing device could be designed. Nanocomposites, binary oxides, inner transition metal oxides (ITMO), CNT based sensors, graphene-based sensors, conducting polymers composites based sensors, C, N, S doped sensors, transition metal and non-metal doped sensors, and intrinsic conducting polymer-based sensors were used for the sensing purpose of a large variety of gases[49-59]. Moreover, the transition metal-doped oxides are found to be very useful to design a high-quality sensor. According to the literature, the d-block metals dopant could decrease the bandgap in semiconducting metal oxide like ZnO and enhance their optical properties[60-62]. Zinc oxide nanomaterial occurs in different types of structures. The one-dimensional form includes nanorods, needles, belts, wires, etc., two-dimensional form includes nanosheets and the three-dimensional form includes flowers, snowflakes, etc. The zinc oxide material can exist in three types of crystal lattice; wurtzite, zinc blende and rock salt. The thermodynamically most stable form is the wurtzite structure in which the zinc is co-ordinated with the four oxygen atoms in a tetrahedral shape. Most of the semiconducting metal oxides have bandgap in the range of 3.5-4 eV by using the metal dopants the bandgap is reduced for the semiconducting metal oxides[63,64]. In addition, many structural and electronic properties can be enhanced for most of the pure semiconducting materials[65,66]. Hence transition metal doping is effectively utilized to modify many structural and electronic properties of the undoped materials.

There are many hazardous gases that evolved during the chemical processes, due to the burning of fuels, chemical reactions, petroleum refining and automobile exhaust. These toxic gases are harmful to both the animals and plants. In many cases the severe breathing problems, respiratory infections, cyanosis, suffocation, dullness, skin and eyes irritation, and other severe damages to the environment and plants. In the present research, undoped and doped zinc oxide nanoparticles were prepared by the co-precipitation method and their thick films were prepared by the screen printing method. The prepared sensors were utilized to sense some of the hazardous gases such as CO, CO_2, NO_2, NH_3, LPG, formaldehyde vapors, toluene vapors, and also for relative humidity. The main purpose of

the doping transition metals into the ZnO lattice was to investigate comparative results between undoped ZnO and modified ZnO. The modified ZnO has porous nature, improved surface area and declined band gap, hence operated as highly efficient sensors for NH_3, CO_2, NO_2, LPG vapours and relative humidity.

MATERIALS AND METHODS

All the chemicals used in the synthesis are of AR grade purchased from a local distributor, Nashik (Make: Sigma-Aldrich and SD fine) and were used without further purification. Chemicals used are $Zn(NO_3)_2.6H_2O$,$Fe(NO)_3.9H_2O$,$Ni(NO_3)_2.6H_2O$, NaOH and deionized water.

Synthesis of Zinc oxide by co-precipitation method

ZnO nanoparticles were synthesized by the co-precipitation method using zinc nitrate ($Zn(NO_3)_2.6H_2O$) and NaOH as precursors. In the present method, an aqueous solution (0.02 M) of zinc nitrate was prepared with deionized water. This solution was stirred on a magnetic stirrer at room temperature for 30 minutes. After this, the solution was stirred at 80°C and 0.02 M NaOH was added dropwise over a period of 30 minutes until pH=12. After the complete addition of NaOH, the solution turns turbid and was stirred at 80°C further for 3 hours. Then it was subjected to ultrasound irradiation for a period of 30 minutes. The obtained off white product was centrifuged at 5000 rpm for 30 min and washed with deionized water and ethanol. The obtained product was dried at 110°C in an oven for 12 h and then grinded using mortar-pestle. The finely grinded product was then calcined at 500°C in a muffle furnace for 3 h to obtain zinc oxide nanoparticles.

Synthesis of Fe^{3+} doped zinc oxide and Ni^{2+} doped Zinc oxide nanomaterials

Similar method which was used for the synthesis of undoped ZnO is used for the synthesis of Fe^{3+} doped ZnO and Ni^{2+} doped ZnO materials. The 1.5% mole concentration doping was carried out for incorporating Fe^{3+} and Ni^{2+}.

Fabrication of thick film sensor of undoped ZnO nanoparticles

The thick film sensor of undoped ZnO nanomaterial was prepared by the screen printing method. Here the inorganic and organic proportion was sustaining 70:30 respectively. The inorganic part consists of undoped ZnO nanoparticles, while the organic segment consists of 8% BCA (Butyl Carbitol Acetate) and 92% ethyl cellulose. All these compounds weighed and diversified in mortar and pestle (clean and dried by acetone) for nearly 30 min To this mixture BCA was appended dropwise slowly to the above blend to obtain the psedoplastic phase (thixotropic), to get a viscous paste. This pulp was then applied on previously cut glass substrate (2x2 cm), by the screen printing procedure. The polymer film of nylon (40 s, mesh number 355) was utilized for the screen printing technique. The standard mask size was developed on the shade by the photolithography technique. After complete coating, the films were dried at atmospheric temperature for 20 min and then films were dried under an infra-red lamp for 30 minutes. Then these thick film sensors were calcined under muffle furnace at 450°C for 3 hours. The undoped ZnO thick film sensors are now ready for characterization and further use.

Fabrication of thick film sensor of 1.5% Fe^{3+} doped ZnO and 1.5% Ni^{2+} doped ZnO nanoparticles

The thick film sensors of 1.5% Fe^{3+} doped ZnO and 1.5% Ni^{2+} doped ZnO nanoparticles prepared by a standard screen printing method. Here the inorganic and organic proportion was sustaining 70:30 respectively. The inorganic part consists of 1.5% Fe^{3+} doped ZnO and 1.5% Ni^{2+} doped ZnO nanoparticle while the organic segment consists of 8% BCA (Butyl Carbitol Acetate) and 92% ethyl cellulose. All these compounds weighed and diversified in mortar and pestle (cleaned and dried by acetone) for nearly 30 min To this mixture BCA was appended dropwise slowly to the above blend to obtain the psedoplastic phase (Thixotropic), to get a viscous paste. This pulp was then applied on previously cutted glass substrate (2x2 cm), by screen printing procedure. The polymer film of nylon (40 s, mesh number 355) was utilized for the screen printing technique. The standard mask size was developed on the shade by the photolithography technique. After complete coating, the films were dried at atmospheric temperature for 20 min and then films were dried under infra-red lamp for 30 minutes. Then these thick film sensors were calcined under muffle furnace at 450°C for 3 hours. The undoped ZnO thick film sensors are now ready for characterization and further use.

Thickness measurement of the films

The surface coating of the films was measured by using equation (1), the thickness of the undoped ZnO films was found to be 7.407 um (7407 nm), for 1.5% Fe^{3+} doped ZnO, the thickness of the film was found to be 6.51µm (6510 nm), while thickness for 1.5% Ni^{2+} doped ZnO observed to be 6.213 µm (6213 nm). The thickness of all the prepared sensors was measured by mass difference method. The thickness of the film was found in the thick region.

$$t = \Delta M / A \times \rho \quad (1)$$

ΔM = Mass difference of the film before and after deposition

ρ = Composite density of undoped and doped zinc oxide (ZnO)

A= Area of the films

RESULTS AND DISCUSSION

X-ray diffraction (XRD) studies

The undoped ZnO, Fe^{3+} doped ZnO and Ni^{2+} ZnO calcined at 500 were characterized by XRD, with model number D8 advance Bruker AXS GmbH (Germany). The films were analyzed at Room temperature with CuKα radiations (wavelength 1.54 Å). The XRD spectrum as depicted in Fig. 1a-c shows the formation of crystalline zinc oxide as per data obtained. The Braggs reflection peaks are attributed to the formation of ZnO hexagonal lattice with crystal lattice and p63mc space group, having molecular weight 81.38 g/mole with a volume of lattice 47.62. The match scan data of ZnO shows the formation of crystalline ZnO nanoparticles with JCPDS number 00-036-1451. Diffraction peaks obtained are 31.79, 34.45, 36.28, 47.59, 56.66, 62.93, 68.02, 69.18, 72.66, 77.04 can be assigned to the reflection of (100), (002), (101), (102), (110), (103), (200), (112), (201), (202) planes. No additional peaks of any compound or impurity were observed in the XRD spectrum indicating that the prepared zinc oxide is pure. The diffraction peaks for Fe^{3+} doped ZnO and Ni^{2+} doped ZnO have nearly same two theta values in comparison to the undoped ZnO. Since the dopant concentration was not very sufficient to shift the two theta values largely. All the above-cited diffraction patterns confirm the formation of ZnO nanoparticles. The average particle size was calculated by using Debye-Scherer's formula. [$D = K\lambda/\beta \cos\theta$], where D is average particle size, K is constant (0.9 to 1), β is full-width half maxima (FWHM) of the diffracted peak, θ is the angle of diffraction. The average particle size for undoped zinc oxide was found to be 23 nm, for 1.5% doped Fe^{3+} it was 19 nm and for 1.5% Ni^{2+} doped ZnO, it is found to 29 nm.

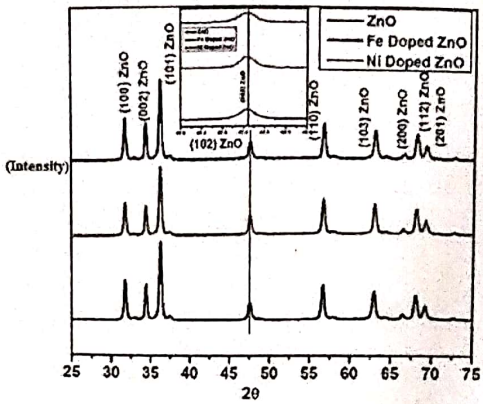

Fig. 1 (a). XRD spectrum of undoped ZnO thick films (b) XRD spectrum of 1.5% Fe^{3+} doped ZnO thick films. (c) XRD spectrum of 1.5% Ni^{2+} doped ZnO thick films

Field Emission Gun Scanning Electron Microscopy: (FEG-SEM)

The surface morphology, surface and porosity of the ZnO nano powder was affirmed from scanning electron microscopy. Fig. 2 a-f shows the SEM micrographs of undoped ZnO, 1.5% Fe^{3+}doped ZnO and 1.5% Ni^{2+} doped ZnO nanoparticles respectively. The undoped ZnO is given in Fig. 2 a-c distinctly appearing with a hexagonal crystal lattice with heterogeneous structure alongside some void space over the cross section. The 1.5 % doped Fe^{3+} ZnO nanoparticles images as depicted in Fig. 2-b where the large voids/cavities are seen alongside the crystal lattice of ZnO. The 1.5% Ni^{2+} doped ZnO images are given in Fig. 2-c. Here the flakes crystals of ZnO appeared in hexagonal shaped can be seen with the various dimensions. From the SEM pictures, it can be seen that the undoped and doped ZnO are exceptionally permeable with certain voids over the outside of the cross section. Normal permeable material is exceptionally valuable for the detecting component, as the permeable material gives straightforwardness to adsorb the gases/vapors yielding the more reaction for vaporous particle superficially through chemisorption and physisorption. In doped ZnO framing littler chunks of different nanosized nanoparticles, while in undoped ZnO the little estimated nanoparticles are exceptionally

agglomerated to shape a heterogeneous cross section can be seen from SEM pictures. Overall, SEM images of all materials indicate that prepared materials have a good surface nature. All the gas sensing properties are surface properties, hence the interstitial voids present all over the surface of undoped and doped ZnO found to be effective for gas sensing phenomenon.

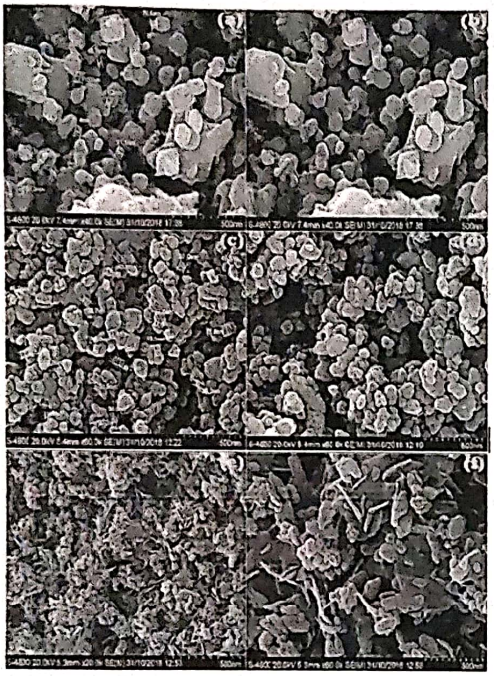

Fig. 2 (a-b). SEM image of undoped ZnO (c-d) SEM image of 1.5% Fe^{3+} doped ZnO (e-f) SEM image of 1.5% Ni^{2+} doped ZnO

Energy dispersive spectroscopy (EDS)

The energy dispersive spectroscopy was utilized to investigate the elemental composition of prepared material ZnO, Fe^{3+} doped ZnO and Ni^{2+} doped ZnO. All prepared material is found in proper elemental composition as represented in Fig. 3 a-c. In the EDS spectrum the elements have appeared in their normal scale position. For instance, in all the EDS spectrum represented in Fig. 3 a-c the elemental zinc is resolute at 8.5 KeV. The iron is resoluted at characteristic scale of 8.5 KeV and nickel is sharply resolved at 7.5 KeV scale. The elemental oxygen is resoluted at characteristic scale of 1.0 KeV in a very spectrum of undoped and doped ZnO depicted in Fig. 3 a-c. Thus, the prepared materials undoped ZnO and doped ZnO are in proper elemental and weight composition. The composition of all these elements is tabulated in their EDS spectrum.

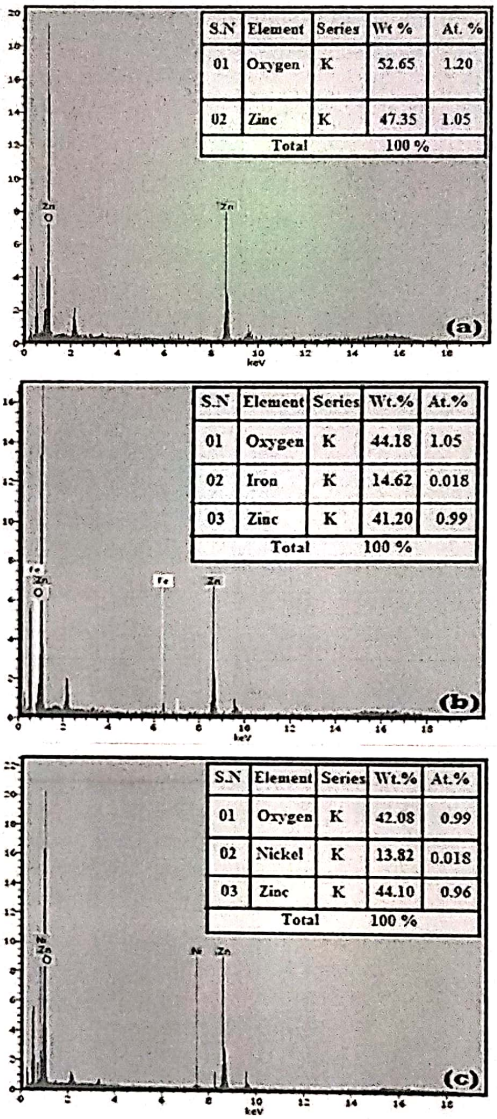

Fig. 3 (a). EDS spectrum of undoped ZnO (b) EDS spectrum of 1.5% Fe^{3+} doped ZnO (c) EDS spectrum of 1.5% Ni^{2+} doped ZnO

Brunauer-Emmett-Teller (BET)

Brunauer-Emmett-Teller (BET) analysis was performed for undoped ZnO, Fe^{3+} doped ZnO and Ni^{2+} doped ZnO thick film sensors with the ease of nitrogen adsorption-desorption experiment. This experiment was utilized to seek the information of porous material, as well as pore size distribution over the catalyst/sensor surface since, all the sensors were utilized for the gas sensing phenomenon which is a surface property. Hence,

the investigation of the available surface area for chemisorption or physisorption among adsorbate gas molecules and adsorbent sensors is a prime investigation for the gas sensing study. The data obtained from BET analysis i.e. surface area, pore volume/radius, pore size etc. is represented in Table 1. On the other hand, the BET analysis via nitrogen adsorption-desorption experiment is represented in Fig. 4 a-c. Among the six BET standard adsorption isotherm, the present isotherm represented in Fig. 4 belongs to type –IV adsorption isotherm from BDDT system for BET analysis.

Table 1: BET N_2 adsorption-desorption curves for undoped ZnO, 1.5% Fe^{3+} doped ZnO 1.5% Ni^{2+} doped ZnO

Prepared Material	Surface Area (m^2/g)	Pore volume (cc/g)	Pore radius (Å)	R2
Undoped ZnO	13.538	0.0380	104.71	0.9998
1.5% Fe^{3+} doped ZnO	23.552	0.0870	107.39	0.9998
1.5% Ni^{2+} doped ZnO	16.134	0.0316	104.68	0.9997

High-resolution transmission electron microscopy (HR-TEM)

The crystal lattice of the modified ZnO material was investigated by means of high-resolution transmission electron microscopy as depicted in Fig. 5 a-c with the resolution at 10 nm, 20 nm and 50 nm respectively. Similarly, the image appeared in Fig. 5d represents selected area diffraction pattern for the modified ZnO material. These bright spots can be assigned to the (h, k, l) planes of prepared material for the characteristic of prepared material. The bright spots that appeared in the SAED pattern constitute the crystalline nature of prepared material. Data obtained for 1.5% doped ZnO material implies formation hexagonal crystal lattice. The images a-c in Fig. 5 justifies the prepared ZnO material with nearly hexagonal type lattice matches with reported literature. As well the TEM results obtained for the prepared material are found to be in good agreement with XRD data. Since X-ray diffraction data for the all prepared sensors proclaims the formation hexagonal crystal lattice.

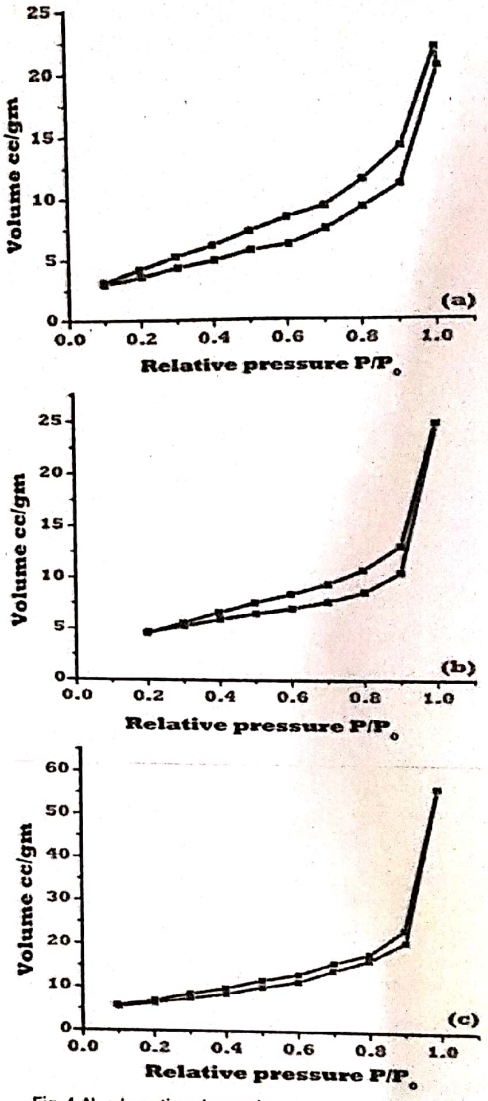

Fig. 4. N_2 adsorption-desorption curves for (a) undoped ZnO, b) 1.5% Fe^{3+}, doped ZnO (c) 1.5% Ni^{2+} doped ZnO

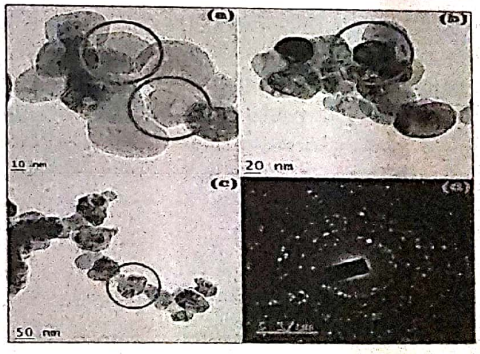

Fig. 5 (a-c). HR-TEM images of 1.5% Fe^{3+} doped ZnO sensor (d) SAED pattern for 1.5% Fe^{3+} doped ZnO sensor material

Electrical resistivity and temperature effect on undoped ZnO, 1.5% Fe^{3+}, doped ZnO and 1.5% Ni^{2+} doped ZnO sensors

The electrical resistivity and consequence of elevated temperature on screen-printed thick film sensors of undoped ZnO, Fe^{3+} doped ZnO and Ni^{2+} doped ZnO were investigated to conclude about the semiconducting behavior of the sensors. The electrical characteristics and gas sensing properties of thick film sensors were investigated with regular potential divider experimental arrangements. Thick film sensors were mounted at the base of the gas assembly chamber in the sample section. In this section Cr-Al thermocouple fixed with the sensor cavity to sense the temperature across the sensors plates. The change in temperature was accessed digitally by temperature recorder with model number PEW-202/PEW-205 from a thermocouple attached to the sensor. The temperature was supplied across the film from 400°C to 50°C. The electrical resistance of all the films was measured in the existence of oxygen and without interruption of any other gases in the glass-domed shaped chamber with the regular set up as depicted in Figure 6.

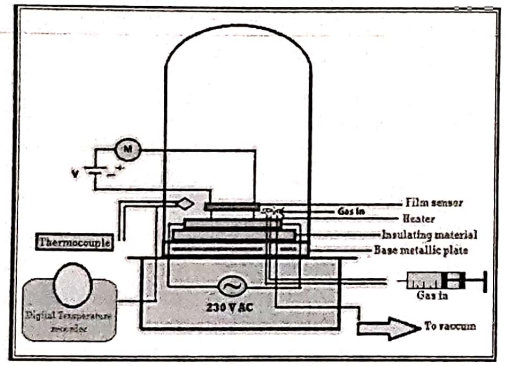

Fig. 6. Gas sensing model diagram utilized in present research

The effect of temperature on the prepared sensors can be seen in Fig. 7. (a,c,e) here the resistance of the film sensor found to be very high at the commencing stage, but with an increment of temperature from 50°C to 400°C, the resistance found to be decreased steadily. The declined resistance is a result of expanding stream versatility of the charge moving or because of grid vibrations related to developing temperature. Where the molecules frequently approach adequate for the exchange the rate transporters and the conduction is started with the guide of cross-section vibration as shown in Fig. 7 a-c. The effect of temperature and activation energy of the prepared thick film sensors was calculated using equation 2 from the plot of Log R versus 1/T as shown in Fig. 7 (b, d, f). During the effect of temperature on the prepared sensors, the cumulated resistivity exhibited by the sensors is an important parameter to conclude about the electrical behavior of the sensors. The total resistivity calculated by equation 3.

$$R = R0\ e^{-\Delta E/KT} \quad (2)$$

R = Resistance varied at different temperatures, R_0 = Resistance at 0°C, $\Delta E/T$ = Variation of energy with temperature i.e. activation energy, ΔE = 2.303 *K* Slope (Calculated from graph), K= Boltzmann Constant (8.61733 X 10^{-5} $eV.K^{-1}$).

$$\rho = R.b.t/L \quad (3)$$

ρ = Resistivity of the film, R = resistance at room temperature, b = breadth of film, t = thickness of the film, L = length of the film.

LT = Low temperature , HT= High temperature

Gas sensing study of prepared sensors for selected gases

The gas sensing study for prepared thick film sensors was performed for some selected gases such as CO, CO_2, NO_2, NH_3, LPG, formaldehyde vapors and toluene vapors (TV). The entire gas sensing experiment was performed by using the homemade gas sensing assembly set up as depicted in Fig. 6. The resistance of the thick film sensors was measured by using the half-bridge method. Here altering the resistance of the thick film sensor resulted in a change in voltage over definite resistance. The voltage over definite resistance, the particular resistance of the film is inter-convertible and can be calculated easily with the aid of Ohms law. The desired concentration of gas was introduced inside the gas chamber and the fixed DC voltage was applied to the film circuit. The film sensor resistance was monitored by digital output voltage millimetre with model number CIE Classic 5170. Every time the selected gas allowed introducing inside the dome-shaped glass chamber, the output voltage response between sensor circuit and gas was recorded with a millimetre. The gas residue was cleaned by supplied fixed temperature inside the gas sensing assembly through the thermostat. The electrical resistance of thick film sensor in the existence of air (Ra) and presence of gas (Rg) was measured to estimate the % response or sensitivity by the sensor to tested gas, given by equation 4.

$$S\% = Ra\text{-}Rg/Ra*100 \quad (4)$$

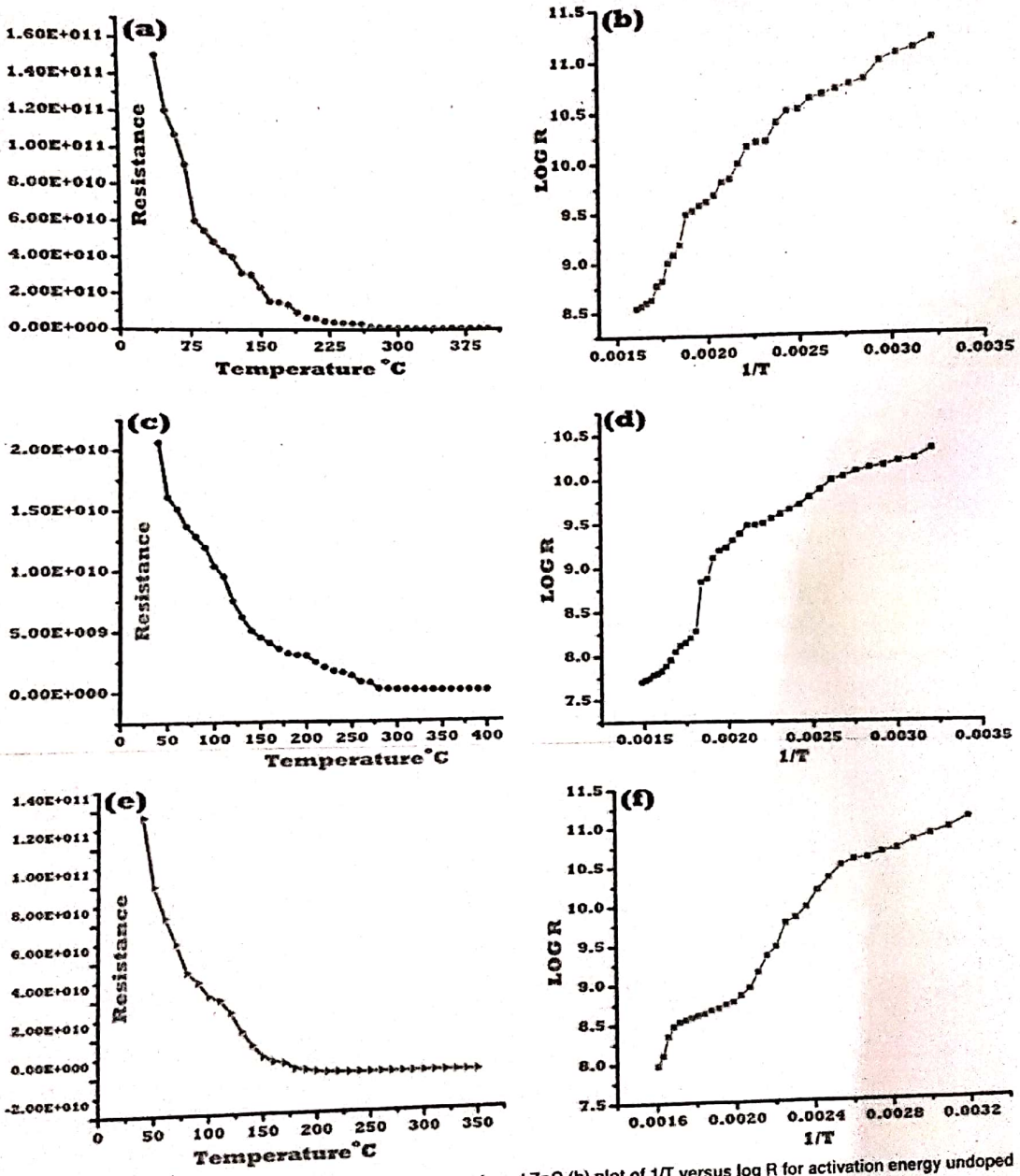

Fig. 7 (a). Variation of resistance with temperature for undoped ZnO (b) plot of 1/T versus log R for activation energy undoped ZnO (c) variation of resistance with temperature for 1.5% Fe^{3+} doped ZnO (d) plot of 1/T versus log R for activation energy 1.5% Fe^{3+} doped ZnO (e) variation of resistance with temperature for 1.5% Ni^{2+} doped ZnO (f) plot of 1/T versus log R for activation energy 1.5% Ni^{2+} doped ZnO

Table 2: Resistivity, activation energy and average grain size for undoped ZnO, 1.5% Fe^{3+} doped ZnO and 1.5% Ni^{2+} doped ZnO sensors

Thick film sensor	Grain Size From XRD (nm)	Resistivity (Ω m)	Activation Energy (eV)	
			L.T.	H.T.
Undoped ZnO	23	11.032×10^5	0.1674	0.2717
1.5% Fe^{3+} doped ZnO	19	6.265×10^3	0.1939	0.2513
1.5% Ni^{2+} doped ZnO	29	7.144×10^3	0.1825	0.232

Gas sensing and electronic characteristics of prepared sensors

ZnO is widely used in semiconducting sensor material for a large category of gases. The estimated band gap range of ZnO is 3.4 eV and it shows typical n-type semiconducting behavior. The n-type semi conduction is attributed to native defects or oxygen vacancies. The inherent carrier density of zinc oxide is found to be 106/cm^{-3} at a normal temperature. While it's internal donor level is nearly 0.5-0.15 eV beneath the conduction band. According to reports its donation density at room temperature is approximately 10 17 /cm^{-3}. The positive hole movement capacity is 5-50 cm^2/(Vs), while the negative ion (electrons) mobility is 200 cm^2/cm^{-3}. All these electronic parameters make ZnO an excellent sensor to sense the wide category of gases. Here tripositive Fe and dispositive nickel is doped into the ZnO lattice. Due to the Fe^{3+} doping NTC (negative temperature coefficient), the character of ZnO is altered to PTC (positive temperature coefficient) since the tripositive iron impurity/dopant providing the additional holes for the conduction. While in the case of nickel doped zinc oxide, some of the Zn^{2+} ions may be replaced by the Ni^{2+} dopant concentration but its NTC character remains to conserve.

Sensitivity of undoped ZnO and modified ZnO for selected gases

The most important parameter of a particular gas sensor is the response given by the sensor to the selected or tested gas so that it can be designed for commercial purposes to get used at demanding places. Here for gas sensing study some of the selected environmental and industrial toxic gases were selected that are exhausted in various chemical processes. The gases like CO, CO_2, NO_2, NH_3, LPG, formaldehyde vapors, and toluene vapors are toxic and selected for sensing purposes for the fabricated sensors in the present study. The optimum response recorded for these gases at different temperatures is listed in Table 3. The plot of % sensitivity against temperature is depicted in Fig. 8a-c. Undoped ZnO is popularly used as a promising sensor for many common gases such as H_2S, NH_3, Methane, SO_2, NO_2, Cl_2, acetone, ethanol, methanol, etc. Here we utilized the ZnO and modified ZnO to sense some highly toxic gas vapors like CO, CO_2, NO_2, NH_3, LPG, Formaldehyde vapors and toluene vapors (TV). Out of these above-listed gases very rare reports have reported on gas sensing properties of LPG, formaldehyde vapors, and toluene vapors (TV). Here very interesting results have been investigated for these toxic gases and especially Fe^{3+} doped ZnO was found to be very sensitive for these gases. The detailed statistics about the gas sensing study are highlighted in Table 3. The most interesting results obtained for Fe^{3+}/ZnO thick film sensor, here the response for the iron modified ZnO sensor for CO_2 to be 76.62% at 150°C and for NH_3 vapors response up to 76.58% at 150°C was observed for Fe^{3+}/ZnO thick film sensor. Similarly for CO, LPG, NO_2, CH_2O, toluene vapors, the response by Fe^{3+} doped ZnO was found to be 68.59%, 65.12%, 70.12%, 35.12% and 22.46% respectively. The interesting results for iron-doped ZnO are attributed to high surface area from BET analysis, declined bandgap of iron-doped ZnO in comparison to undoped ZnO, excellent porous nature of Fe^{3+}/ZnO thick film sensor which leads to highly efficient interaction between gases and surface-active sensor. The reduced bandgap in case of iron-doped ZnO, the conduction band of iron is close to the valence band of ZnO and hence the ease of electron transportation and redox mechanism is very rapid in case of iron-doped ZnO sensor surface amid the selected gases.

Table 3: Comparative chart for gas response in undoped ZnO, 1.5% Fe^{3+}doepd ZnO and 1.5% Ni^{2+}doepd ZnO at 100 ppm

Gas (100 ppm)	%S undoped ZnO	Optimum sensing Temperature (°C) undoped ZnO	%S Fe^{3+} doped ZnO	Optimum sensing Temperature (°C) Fe^{3+}doped ZnO	%S Ni^{2+} doped ZnO	Optimum sensing Temperature (°C) Ni^{2+}doped ZnO
CO	52.25	250	68.59	200	62.12	200
CO_2	55.12	100	76.62	150	71.2	150
NO_2	58.16	100	70.12	100	69.48	100
NH_3	59.23	150	76.58	150	70.23	150
LPG	62.15	100	65.12	100	63.12	200
CH_2O vapours	37.89	200	35.12	100	32.25	150
Toluene Vapours	19.58	100	22.46	200	20.12	100

TV = Toluene vapours, CH_2O = Formaldehyde, %S = Gas response, LPG = Liquefied petroleum gas

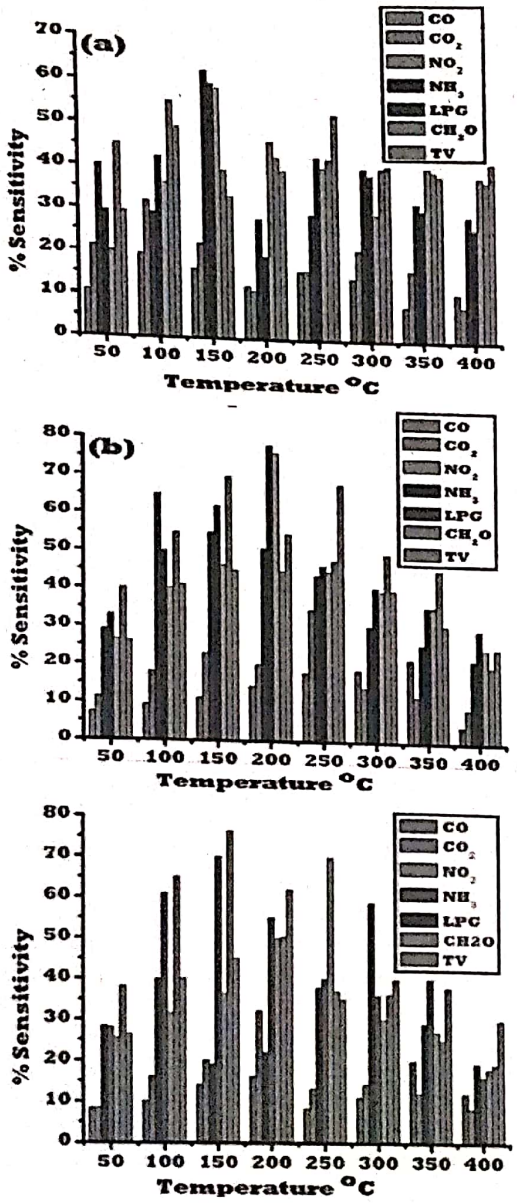

Fig. 8 (a). %sensitivity of tested gases at optimum temperature for undoped ZnO, (b) %sensitivity of tested gases at optimum temperature for Fe^{3+} doped ZnO, (c) %sensitivity of tested gases at optimum temperature for Ni^{2+} doped ZnO

Selectivity of undoped ZnO and modified ZnO for selected gases

The selectivity by the sensor to particular gas is a prime parameter for the every sensor material. In Fig. 9, the selectivity of all tested gases for fabricated thick film sensors is depicted. The selectivity of gases was computed by utilizing equation 5. From the data of calculation maximum selectivity was shown by bromine vapors. The prepared sensors viz. Fe^{3+} doped ZnO and Ni^{2+} doped ZnO sensors showed selectivity 100 % for CO_2 gas, and undoped ZnO showed 100% selectivity for LPG gas. The high selective gas after CO_2 observed to be ammonia vapors, showed sensitivity for undoped ZnO was 95.30%, then Fe^{3+} doepd ZnO at 99.94% and for Ni^{2+} doped ZnO showed selectivity for phosphine gas was 98.63%. The selectivity by other toxic gases was CO, NO_2, LPG, formaldehyde vapors and toluene vapors were also very high all the sensors. Previously the selectivity and sensitivity of toluene vapors, LPG, and formaldehyde vapors are very rarely reported for undoped and modified ZnO sensors. Percentage selectivity of all tested gases for prepared sensors is as depicted in Table 4.

$$\%\text{Selectivity} = (S_{\text{target gas}}/S_{\text{High responding gas}})^*100 \quad (5)$$

$S_{\text{other gas}}$ – sensitivity of films for target gas

$S_{\text{target gas}}$ - sensitivity for films for high responding gas

Table 4: Selectivity of prepared sensors for tested gases

Tested gases	%Selectivity for thick film sensors		
	Undoped ZnO	Fe^{3+}doped ZnO	Ni^{2+}doped ZnO
CO_2	88.68	100	100
CO	84.07	89.51	87.24
NO_2	93.58	91.51	97.58
NH_3	95.30	99.94	98.63
LPG	100	84.99	88.65
CH_2O vapours	60.96	45.83	45.29
TV	31.50	29.31	28.25

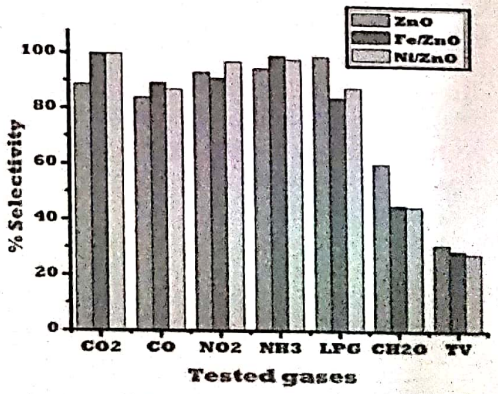

Fig. 9. Selectivity for tested gases by undoped ZnO and modified ZnO sensors

Humidity sensing performance of undoped and modified ZnO sensors

In most of the important fields like the medicinal sector, food processing units, research and development laboratories, clinical trials, etc. relative humidity (RH) plays a vital role in

maintaining good environmental conditions. Here prepared sensors utilized as humidity sensors in addition to gas sensors. There various types of humidity sensors, but ceramic types of sensors have an advantage due to small size, low-cost fabrication and high stability. The elevated signal arises in ceramic category sensors mainly due to the adsorption of aqua molecules nearby in the atmosphere or on the exterior of the sensing device. The change in output electrical signal against the relative humidity % is as shown in Fig. 10. It can be seen from Fig. 10 the change in output electrical signal for relative humidity is showing considerable variation for prepared sensor Fe^{3+} doped ZnO at different operational frequencies like 10 Hz, 100 Hz 500 Hz. The signal sharply changes for iron-doped ZnO sensors for 10 to 90% relative humidity at 10 Hz. It can be seen from Fig. 10 impedance rapidly declined more than three proportions when the relative humidity fluctuated from 10 to 90% exhibits the highest response and best regression throughout the humidity scale. Therefore 10 Hz is the optimum operational range in this setup. The change in resistance against relative humidity is as shown in Fig. 11. The highest response for iron-doped ZnO is can be seen from Figure 11.

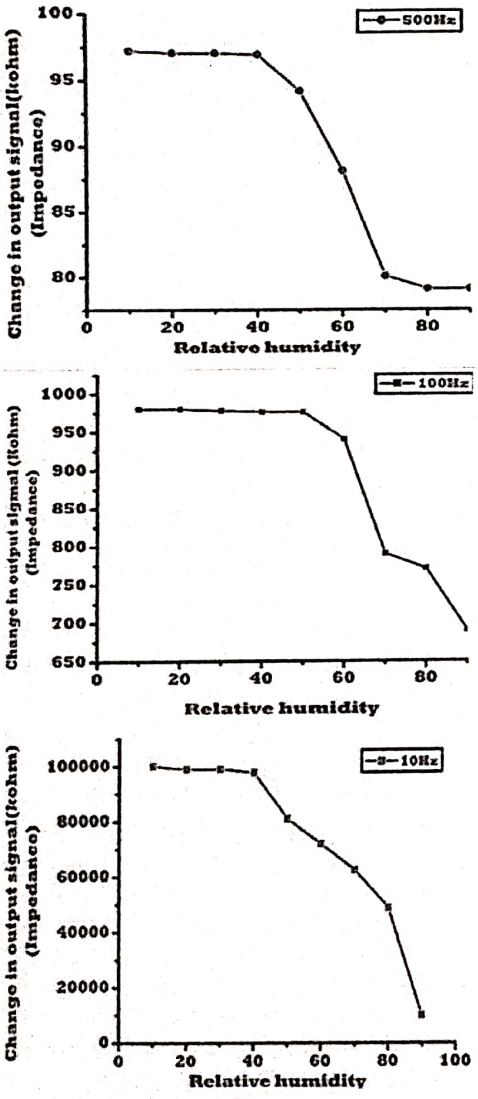

Fig. 10. Impedance verses relative humidity for prepared Fe^{3+} doped ZnO sensors at 10Hz

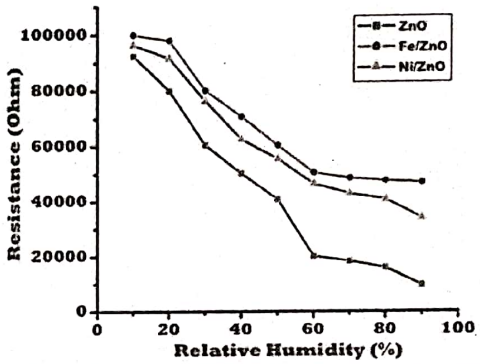

Fig. 11. The humidity loops characteristic of prepared sensor measured at 10 Hz

Response and Recovery

The response and recovery is an important parameter to design the sensor for a particular gas. In the present research best response was recorded for 1.5% Fe^{3+} ZnO sensor for bromine vapors, formaldehyde, ammonia, and toluene vapors. Hence response and recovery were conducted these four gases. For all these gases the response was recorded at 100 ppm gas concentration of each gas. The optimum response and recovery time for all the gases areas are mentioned in Table 5. As mentioned, the response and recovery rate was rapid for formaldehyde vapors and toluene vapors.

Table 5: Summary of response and recovery of tested gases for 1.5 % Fe^{3+} doped ZnO sensor

Entry	Gas	Response%	Response time in seconds	Recovery time in seconds
1	CO_2	76.62	33	54
2	NO_2	70.12	30	43
3	NH_3	76.58	22	45
4	LPG	65.12	18	38

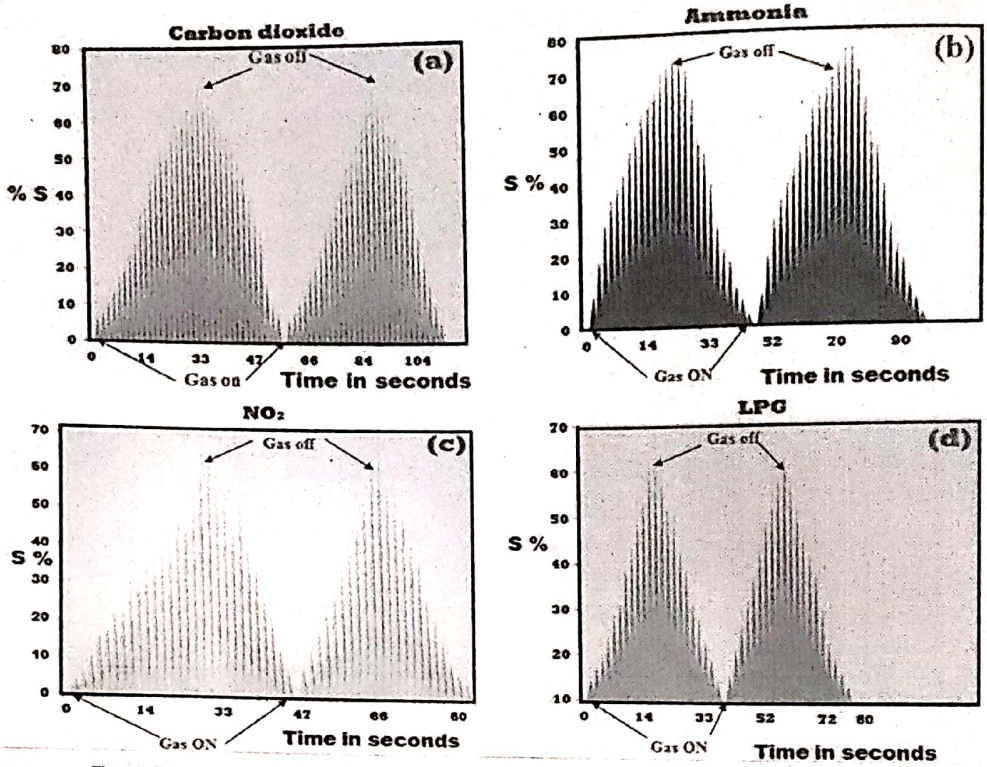

Fig. 12. Response and recovery graphs of 1.5% Fe^{3+} doped sensor for (a) Br_2, (b) formaldehyde vapours (c) ammonia vapours (d) toluene vapours

Recycling ability of prepared sensors

The recycling performance of ZnO, 1.5% Fe^{3+} ZnO, and 1.5% Ni^{2+} ZnO sensors was tested for bromine vapors; formaldehyde, ammonia, and toluene vapor sensors. The recycling performance is one of the prime parameters for the sensor. For the productive functioning of the sensor, the response for particular gas must be reproducible. Hence recycling performance of the gases was investigated. All the gases were operated at 100 ppm concentration and all sensors were tested periodically at the time interval of 8 days for the selected gases. The graphs representing the recycling performance of tested gases are represented in Fig. 13. After the repetition of every cycle for each gas, the percent response for each gas found declined with low variation. The observation concerning decrease in the response for each cycle after 8 days performance, the clarification could be give out to this decline is the lessening in the surface activity of the sensors. As these sensors oppressed as often as possible for the testing, the upper surface movement found to bring down due to uncovering of gas each time consequently its adsorption property brought down. In this manner, consistent abatement saw in the affectability reaction by these sensors.

Comparison of prepared sensors

The prepared modified (Fe^{3+} doped ZnO) ZnO thick film sensor prepared by the screen printing method was compared with other zinc nanocomposites, transition metal-doped ZnO sensors and ZnO based reported gas sensors and also other sensors. The iron modified ZnO catalyst used to sense the above-listed gas vapors and these modified sensors is found to be extraordinary for sensing these gases. In the present investigation modified ZnO catalyst is characterized by several properties. From this investigation, it is found that this catalyst has a considerable surface area and declined band in comparison to the undoped ZnO. Hence these modifications in structural and electronic properties construct the modified ZnO sensor different among the rest of the sensors to sense selected gases. The comparison of the tested gases for modified ZnO sensor and other reported ZnO based sensors is presented in Table 6.

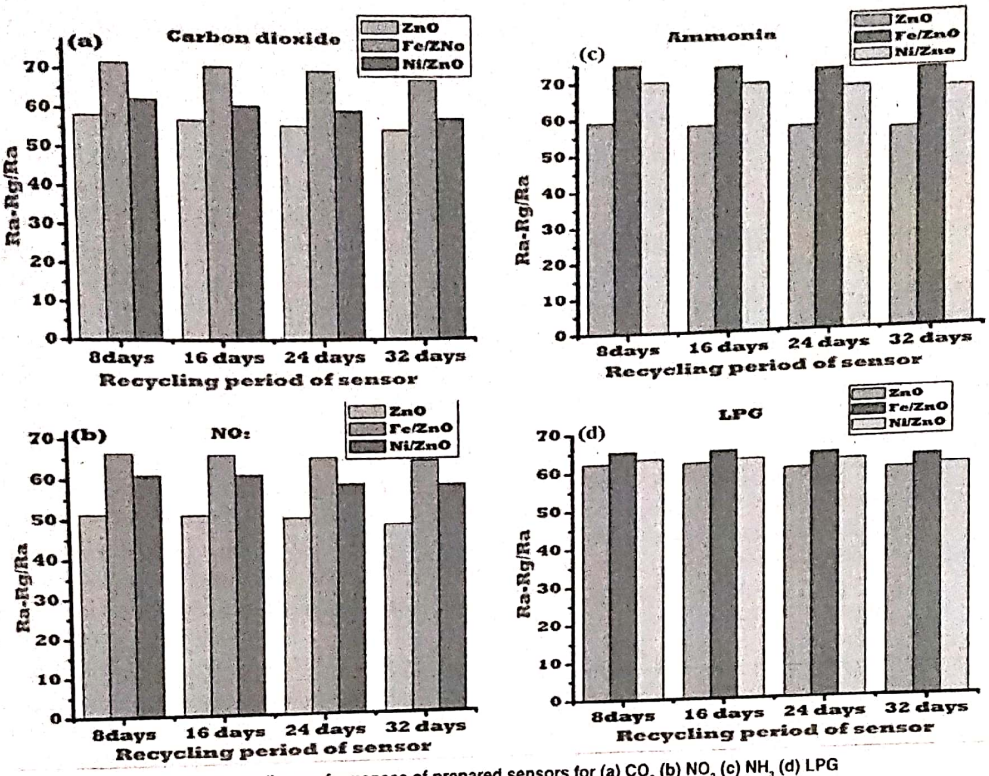

Fig. 13. Recycling performances of prepared sensors for (a) CO_2 (b) NO_2 (c) NH_3 (d) LPG

Table 6: Comparative studies of carbon dioxide for modified ZnO sensor and reported sensors

Sensor	Method of Fabrication	Type of sensor	Sensing Temp. (°C)	Gas in ppm (CO_2)	Reported Sensitivity (%)	Reference
CuO	Cinterred ceramics	Thin Film	250	5000	48	67
Fe_2O_3	Spin coating	Thin film	-	20	20	68
La_2O_3/SnO_2	LPCVD	Thin film	350	1000	30	69
$LaOC_3$	NW Coating	Thin film	400	4000	5	70
Cr^{3+},Co^{2+} doped $LaFeO_3$	Spin coating	Thin film	100	500	50.17	8
MoO_3:NiO	Hydrothermal	Thick film	150	1000	87.7	71
SnO_2-NiO/ZnO	RF-Sputtering	Thin film	-	--	-	72
1.5% Fe^{3+} doped ZnO	Screen printing	Thick film	150	100	76.62	Present work

CONCLUSION

The undoped ZnO, 1.5% Fe^{3+} doped ZnO, and 1.5% Ni^{2+} doped ZnO were prepared by the co-precipitation method, while thick films were fabricated with assists of standard screen-printed technique. These all sensors utilized for sensing of CO, CO_2, NO_2, NH_3, LPG, formaldehyde vapors, and toluene vapor. The ZnO and modified ZnO very rarely utilized for sensing purposes of CO_2, NH_3, NO_2 and LPG vapors. Among all three prepared sensors the Fe^{3+} doped ZnO sensor was found to be highly sensitive and selective for CO_2, NH_3, NO_2 and LPG vapors, approximately 76.62%, 76.58%, 70.12 %, and 65.12 response was recorded at 150°C, 150°C, 100°C, 100°C respectively for each as 100 ppm. The Fe^{3+} doped ZnO sensors were also utilized as a humidity sensor and high humidity sense was recorded in comparison to the undoped ZnO and Ni^{2+} doped ZnO sensor. The high gas sensing performance of the Fe^{3+} doped ZnO sensor may be attributed to the high surface area, porous nature, and reduced band gap. In the additional study, all three sensors have excellent recycling performance for CO_2, NO_2, NH_3, and LPG gases. The iron modified ZnO sensor has

rapid response and recovery for CO_2, NO_2, NH_3, and LPG gases. Thus, in comparison, it can be concluded the iron-doped ZnO sensor found to be exceptional sensor CO_2, NO_2, NH_3 and LPG gases at moderate temperature as well a good sensor for relative humidity.

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Conflict of Interest

The authors declare no conflict of interest.

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Sahyadri Shikshan Mandal,

Mahant Jamanadas Maharaj Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

Department of Chemistry
M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik

MOU Activity With

Department of Chemistry
Jijamata Arts and Science College Bhenda Tal- Newasa, Dist-Ahmednagar

Department of Chemistry, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organized as Guest lecture on "**Bioinorganic Chemistry in Human Body**" during 19th November, 2019. In this program Dr. M.E. Navgire (Incharge of P.G. Section and IQAC coordinator), Jijamata Arts and Science College Bhenda Tal- Newasa, Dist-Ahmednagar, delivered a lecture on "Bioinorganic Chemistry in Human Body".He explain about the Hemoglobin structure which is present in human blood and their importance in human body functioning.There is 45 more students take advantage of this interactive talk. At the time of talk Dr. D. T. Tayde, Assistant Professor & Head of Department of Chemistry, Mr. R.H. Waghchure, Mr.R.M. Nikam and Mr. T.C. Gaikwad were present for this session.

M.J.M.A.C.&S. College Karajali Tal.Peth, Dist.Nashik

Principal
M.J.M. Arts, Commerce &
Science College Karajali,
Tal.Peth, Dist.Nashik

Phy

SahyadriShikshanMandal's,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik, Department of Physics

MOU Activity With

ShriMarutraoGhulePatilShikshanSanstha's

The Jijamata College of Science and Arts, Department of Physics,Dnyanehshwarnagar

Post Bhende Tal: NevasaDist: AhmednagarPincode: 414605

Department of Physics, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organizedlecture on "**Physics in Daily life**" on 11th Nov., 2019. In this program Chief Guest and resource person Prof. R.B.Bhitre, Professor, Department of Physicsof The Jijamata College of Science and Arts, Department of Physics, Dnyanehshwarnagar. Post Bhende, Tal-Nevasa, Dist-AhmednagarPincode- 414605 delivered a lecture on "Physics in Daily life". After a floral welcome of the guest Principal, Dr.R.Y.Borse, addressed participants that,"Physics is playing a vital role in everyday life and is involved in all the activities what we perform in our daily life . All these activities are involve the principles of physics. Asking importance of physics is like importance of nature itself. after that resource person Prof. R.B.Bhitre,start his lecture with example "The difference between dancing on floor and skating on ice. The difference is of friction as smooth ice provides very little friction against objects, like ice skates. being dragged across its surface. On the other hand floor is providing large friction in comparison to ice. It is due to friction motion is possible as it is not easy to walk on slippery road than to walk on a rough floor. With the conceptual knowledge practical knowledge should also be imparted to the learner. This and many more daily examples were explained and inculcate interest among the participants.

The lecture was not only informative but also encouraged students Teachers and all the listeners to learns about daily life physics concepts and cause of actions . 27 TYBSc students were benefited from this interactive session. This session was highly appreciated by the fellow participants. For the said lectureDr.M.S.Shinde, Prof. TejasKapadane were present. The informative and skilful workshop culminated with a vote of thanks proposed by the Dr.M.S.shinde.

Head
Dept. of Physics
M.J.M. Arts, Comm.& Sci. College
Karanjali Peth, Dist. Nasik 208

I.Q.A.C. Co-ordinator
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Principal
M.J.M. Arts, Commerce
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SahyadriShikshanMandal's,

Mahant Jamanadas Maharaj

Arts, Commerce And Science College, Karanjali (Peth)

M.J.M.Arts, Commerce and Science College Physics Karanjali, Nashik

"Physics in Daily life"

Date: 11th Nov., 2019.

1	Jadhav Kalyan Laxman		
2	Raut Madhuri Pundlik		
3	Bhoye Kiran Rajaram		
4	Bhoye Yogesh Pundalik		
5	Gaikwad Prakash H.		
6	Thepane Tushar Giridhar		
7	Gailcwad Pallavi Vijay		
8	Walvane Ankush Shantaram		
9	Jadhav Kalyan Laxman		
10	Lahane Mahesh Shantaram		
11	Bahmane Ravindra Eknath		
12	Walzade Shubhangi Prakash		
13	Rinrzad Dinesh Laxman		
14	Gawali Jaymala Padmakar		
15	Gawit Manisha Prabhakar		
16	Gawali Madan Bharat		

17	Bhusare Gaurav Pundalik		
18	Gaikwad Chandrakant N.		
19	Gupta Pawan Narendra		
20	Gaikwad Ajay Vijay		
21	Awari Ganesh Ananda		
22	Raut Ajay Prabhakar		
23	Jadhav Rohini Dattu		
24	Dagale davidas Ramdas.		
25	Pardhi Rajendra Raghunath		
26	Gawali Narendra Jagannath		
27	Sahare Pushpa Sudhakar		

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M.J.M. Arts, Commerce
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Karanjali, Nashik-422 208

R.No.ANR/PRG (A)- 5 (S) Date 19-10-1970 L.No.L 25 / N-281 / 73- LC Date 27-04-1973

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ज्ञानेश्वरनगर पो.भेंडे साखर कारखाना-४१४६०५, ता.नेवासा, जि.अहमदनगर.
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जा.क्र./Ref.No. 404/2019-20

दिनांक : 20/12/2019

CERTIFICATE

This is to certify that, ***Mr. Bhangare Kishor Namdev*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on **"Mass Production of Bio-fertilizers".** During **16/12/ 2019 to 20/ 12/ 2019.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head
Soil, Biofertilizer and Biopesticide

Biofertilizer Laboratory
Loknete Marutrao Ghule Patil
Dnyaneshwar S.S.Karkhana Ltd.
Dnyaneshwarnagar, Po. Bhende S.K.
Tal. Newasa, Dist. A.Nagar-414605

R.No.ANR/PRG (A)- 5 (S) Date 19-10-1970 L.No.L 25 / N-281 / 73- LC Date 27-04-1973

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जा.क्र./Ref.No. 4021 2019-20 दिनांक : 20/12/2019

CERTIFICATE

This is to certify that, ***Mr. Gawali Rahul Raghunath*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on "**Mass Production of Bio-fertilizers".** During **16/12/ 2019 to 20/ 12/ 2019.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head
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Sahyadri Shikshan Mandal,

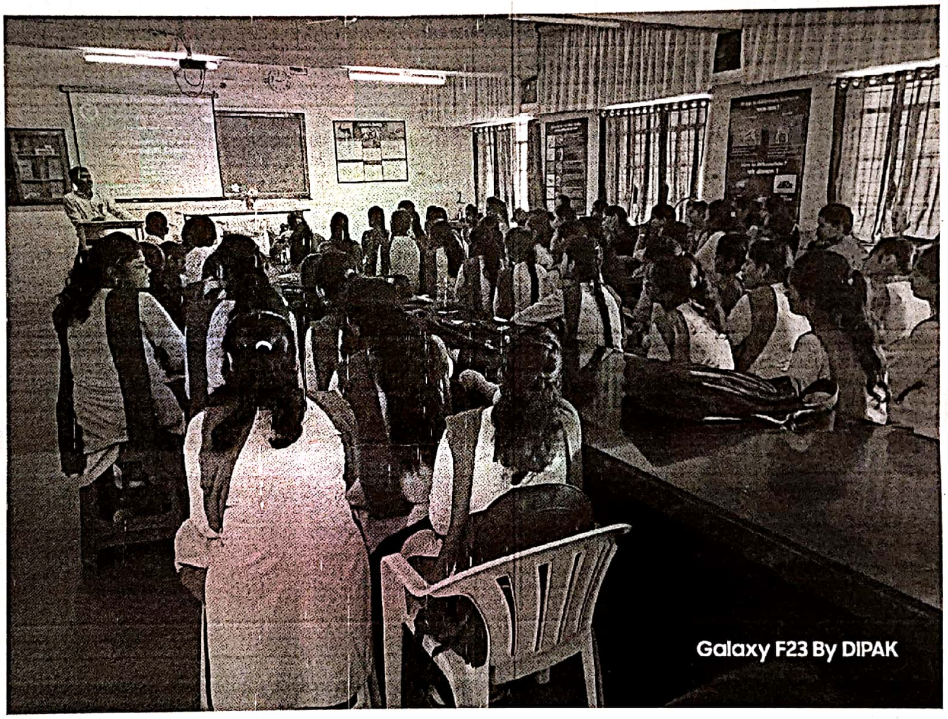
Mahant Jamanadas Maharaj Arts, Commerce And Science College, Karanjali (Peth)

MOU Activity Report

Department of Chemistry
M.J.M.Arts Commerce and Science College Karanjali, Tal-Peth,Dist-Nashik

MOU Activity With

Department of Chemistry
Jijamata Arts and Science College Bhenda Tal- Newasa, Dist-Ahmednagar



Department of Chemistry, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali organized as Guest lecture on "**Coordination Chemistry in Organometallic Compounds**" during 12th September, 2018. In this program Dr.D.T.Tayde,Assistant Professor & Head of Department of Chemistry, Sahyadri Shikshan Mandal Dindori Sanchalit, Mahant Jamanadas Maharaj Arts Commerce and Science College, Karanjali, delivered a lecture on "Coordination Chemistry in Organometallic Compounds". He introduce the students about the organometallic compounds and applications of these compounds in industrial and pharmaceutical era. There is 50 more students benefited from this interactive session.

M.J.M.A.C.&S. College Karajali Tal.Peth Dist.Nashik

Principal
M.J.M. Arts, Commerce & Science College Karajali, Tal.Peth. Dist.Nashik

R.No.ANR/PRG (A)- 5 (S) Date 19-10-1970 L.No.L 25 / N-281 / 73- LC Date 27-04-1973

लोकनेते मारूतराव घुले पाटील ज्ञानेश्वर सहकारी साखर कारखाना लि.,

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जा.क्र./Ref.No. 312/2018-19

दिनांक : 30/12/2018

CERTIFICATE

This is to certify that, ***Mr. Bhoye Ghanshyam Namdev*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on "**Soil Testing Parameters & Mass Production of Biofertilizers**". During **22/12/ 2018 to 30/ 12/ 2018.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head

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This is to certify that, ***Mr. Kakade Shubham Rajendra*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on "**Soil Testing Parameters & Mass Production of Biofertilizers**". During **22/12/ 2018 to 30/ 12/ 2018.**

Best luck for his future.

(Dr. A. S. Jondhale)
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Head

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This is to certify that, ***Mr. Rauit Manohar Chaggan*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on **"Soil Testing Parameters & Mass Production of Biofertilizers".** During **22/12/ 2018 to 30/ 12/ 2018.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head

Soil, Biofertilizer and Biopesticide

Biofertilizer Laboratory
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जा.क्र./Ref.No. 309/2018-19 दिनांक : 30/12/2018

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This is to certify that, ***Mr. Thepane Madhukar Gopinath*** Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on **"Soil Testing Parameters & Mass Production of Biofertilizers".** During **22/12/ 2018 to 30/ 12/ 2018.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head

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जा.क्र./Ref.No. 368/ 2018-19 दिनांक : 30/12/2018

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This is to certify that, *Mr. Gaikawad Anil Motiram* Sponsored by **MJM Art's Commerce And Science College Karanjali** has satisfactory completed the training work on "**Soil Testing Parameters & Mass Production of Biofertilizers**". During **22/12/ 2018 to 30/ 12/ 2018.**

Best luck for his future.

(Dr. A. S. Jondhale)
Co-ordinator

(Dr. B. D. Takate)
Head

Soil, Biofertilizer and Biopesticide

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