Criteria 1.3.3: Curriculum Enrichment
Ph.D -Electronics Engineering

1.3.3 Percentage of students undertaking project work/ field work/ internships (Data for the latest completed academic year) -2022-23

- **Number of students undertaking Research Project Work in Ph.D=5**
- **Total No.of Students enrolled in 2022-23 in Ph.D = 5**

Formula:

$$\frac{\text{Number of students undertaking project work /field work / internships}}{\text{Total number of students}} \times 100$$

- **Percentage of Students Undertaking Project Work/Field Work/Internships = 100 %**

Academic Year 2022-23

Ph.D. Programme of the Faculty of Technology in Electronics Engineering

Year of Enrolment	Brach	Name	Title of the Project
2014-15	Electronics	Mrs. Asma Siddavatam	New Methods to Improve Performance of High Resolution Nuclear Pulse Spectroscopy System
2015-16	Electronics	Mrs. Kanchan Chavan	Time Interval Measurement with High Resolution over Wide Dynamic Range for Nuclear Timing Spectroscopy Applications
2019-20	Electronics	Ms.Tejashree Phatak	Evaluation of Neutron Reaction Cross Section Data
2022-23	Electronics	Mrs.Amrita Jhaveri	Application of Artificial Intelligence , Data Science and Data Analytics in Healthcare and clinical research.
2022-23	Electronics	Mr. N.Gopalkrishnan	FPGA Architecture reconfigurability

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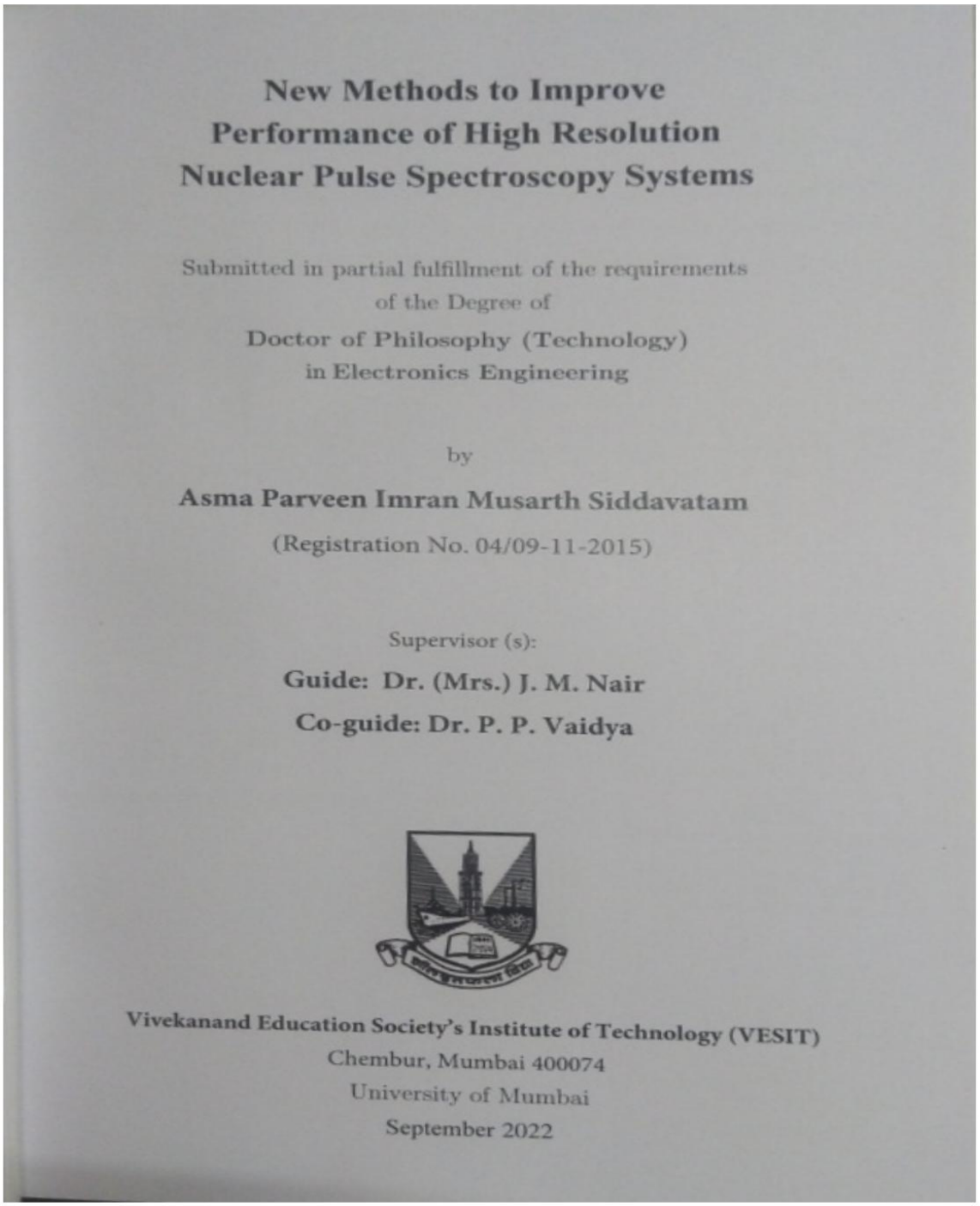
HASHU ADVANI MEMORIAL COMPLEX,
COLLECTOR'S COLONY, CHEMBUR,
MUMBAI-400 074, INDIA.

Name of the Ph.D Researcher :Mrs. Asma Siddavatam

Title: New methods to improve Performance of High Resolution Nuclear Pulse Spectroscopy Systems



New Methods to Improve Performance of High Resolution Nuclear Pulse Spectroscopy Systems

Submitted in partial fulfillment of the requirements
of the Degree of
Doctor of Philosophy (Technology)
in Electronics Engineering

by

Asma Parveen Imran Musarth Siddavatam
(Registration No. 04/09-11-2015)

Supervisor (s):
Guide: Dr. (Mrs.) J. M. Nair
Co-guide: Dr. P. P. Vaidya

Vivekanand Education Society's Institute of Technology (VESIT)
Chembur, Mumbai 400074
University of Mumbai
September 2022

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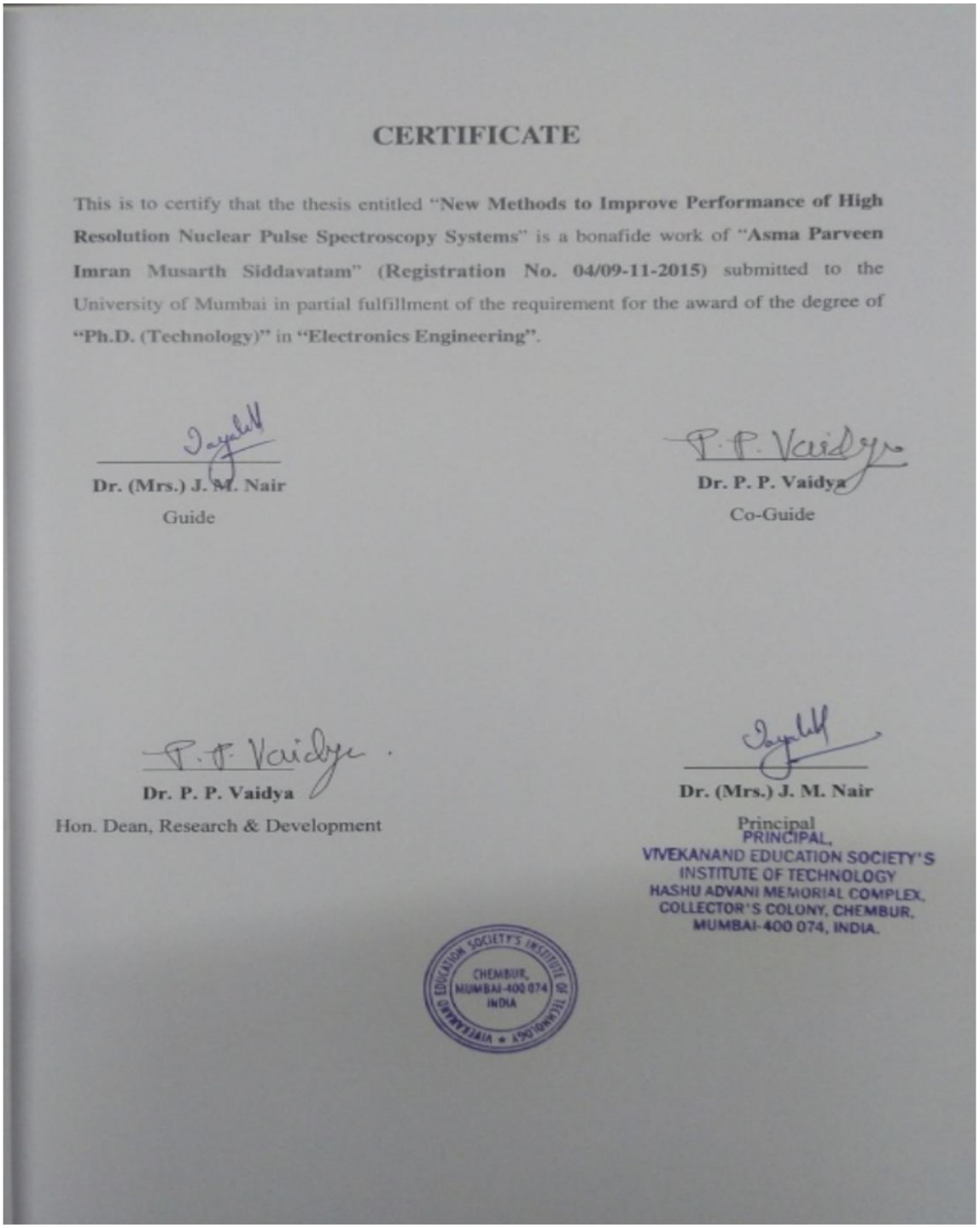

CERTIFICATE

This is to certify that the thesis entitled "**New Methods to Improve Performance of High Resolution Nuclear Pulse Spectroscopy Systems**" is a bonafide work of "**Asma Parveen Imran Musarth Siddavatam**" (**Registration No. 04/09-11-2015**) submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of "**Ph.D. (Technology)**" in "**Electronics Engineering**".

Dr. (Mrs.) J. M. Nair
Guide

Dr. P. P. Vaidya
Co-Guide

Dr. P. P. Vaidya
Hon. Dean, Research & Development

Dr. (Mrs.) J. M. Nair
Principal

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CHEMBUR, MUMBAI-400 074 INDIA

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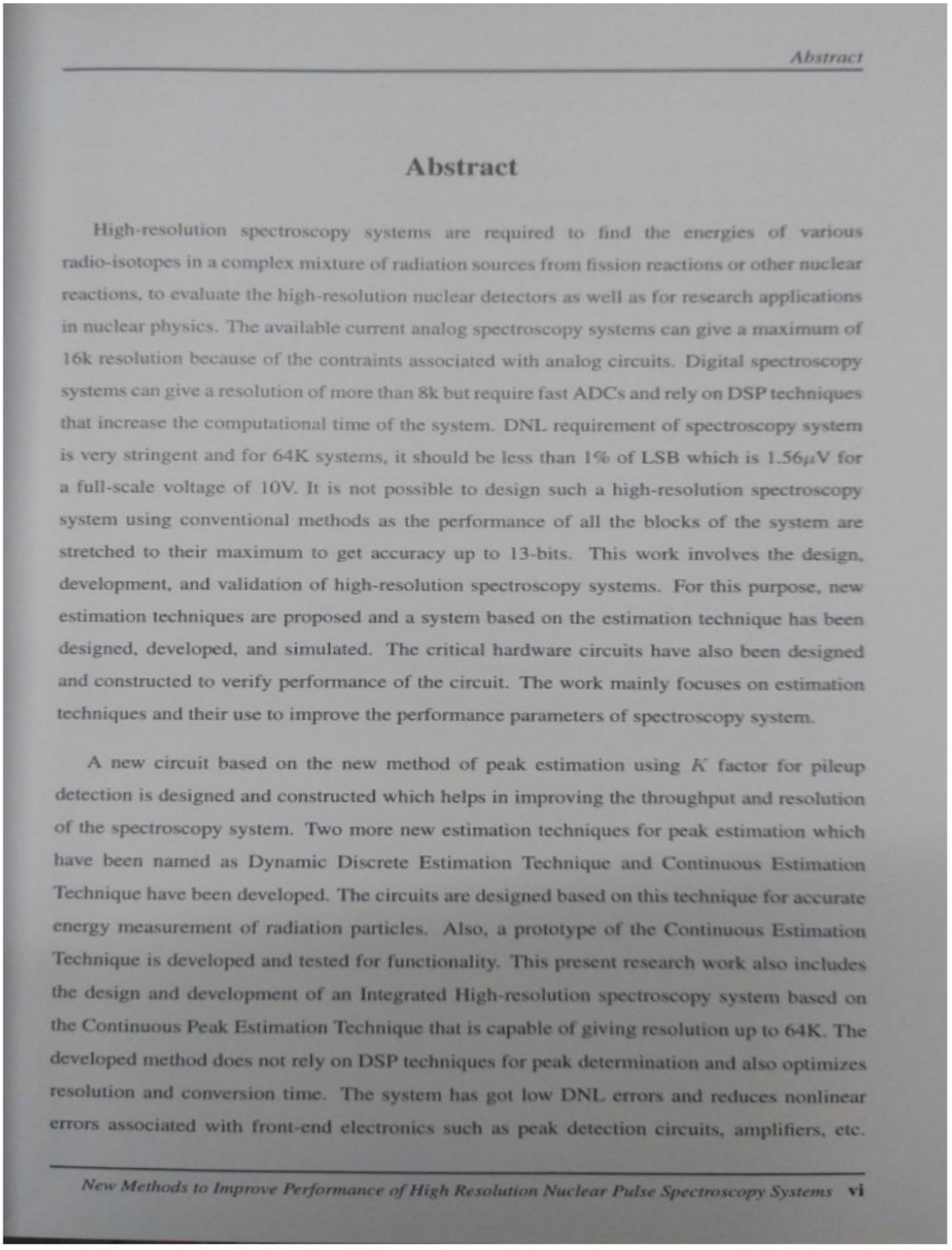

Abstract

High-resolution spectroscopy systems are required to find the energies of various radio-isotopes in a complex mixture of radiation sources from fission reactions or other nuclear reactions, to evaluate the high-resolution nuclear detectors as well as for research applications in nuclear physics. The available current analog spectroscopy systems can give a maximum of 16k resolution because of the contraints associated with analog circuits. Digital spectroscopy systems can give a resolution of more than 8k but require fast ADCs and rely on DSP techniques that increase the computational time of the system. DNL requirement of spectroscopy system is very stringent and for 64K systems, it should be less than 1% of LSB which is 1.56μV for a full-scale voltage of 10V. It is not possible to design such a high-resolution spectroscopy system using conventional methods as the performance of all the blocks of the system are stretched to their maximum to get accuracy up to 13-bits. This work involves the design, development, and validation of high-resolution spectroscopy systems. For this purpose, new estimation techniques are proposed and a system based on the estimation technique has been designed, developed, and simulated. The critical hardware circuits have also been designed and constructed to verify performance of the circuit. The work mainly focuses on estimation techniques and their use to improve the performance parameters of spectroscopy system.

A new circuit based on the new method of peak estimation using K factor for pileup detection is designed and constructed which helps in improving the throughput and resolution of the spectroscopy system. Two more new estimation techniques for peak estimation which have been named as Dynamic Discrete Estimation Technique and Continuous Estimation Technique have been developed. The circuits are designed based on this technique for accurate energy measurement of radiation particles. Also, a prototype of the Continuous Estimation Technique is developed and tested for functionality. This present research work also includes the design and development of an Integrated High-resolution spectroscopy system based on the Continuous Peak Estimation Technique that is capable of giving resolution up to 64K. The developed method does not rely on DSP techniques for peak determination and also optimizes resolution and conversion time. The system has got low DNL errors and reduces nonlinear errors associated with front-end electronics such as peak detection circuits, amplifiers, etc.

Abstract

The design is cost-effective and provides an import substitute for High-resolution spectroscopy systems which so far are not made in India.

The research work also includes the development of a new type of Flash ADC based on the string of resistor and comparators similar to continuous estimation technique that increases the resolution of conventional Flash ADC or in general any type of ADC by connecting a peripheral circuit. It improves resolution without much affecting the parameters sampling rate, complexity, and power dissipation of the overall system. There is an increase in M bits resolution by the use of 2^M resistors, an equal number of comparators, analog multiplexers, buffers, and an amplifier. This method can be used for residue generation in a sub-ranging type of ADCs with hardly any increase in conversion time.

The research work also includes the development and construction of a validation system using the DAC interpolation method that can validate integral and differential nonlinearity of spectroscopy system having a resolution of up to 64K. Also, a system for generating triangular sweeps is developed using string of resistors and analog multiplexer which is simpler in design compared to the DAC interpolation method and requires low-cost basic components that reduce the system development cost. It is possible to achieve a large range of sweep period from a few hundreds of milliseconds to thousands of seconds.

Keywords: *Radiation Particles, Spectroscopy System, High Resolution, Integral and Differential Linearity, Estimation Techniques, Dynamic and Continuous Estimation Techniques, Pileup Detection and Rejection, Flash ADC, Resistive Network, Triangular Sweeps, Validation System, Interpolation Methods*

Name of the Ph.D Researcher :Mrs. Kanchan Chavan

Title: Time Interval Measurement with High Resolution over Wide Dynamic Range for Nuclear Timing Spectroscopy Applications

Year - 2022 -23 - Synopsis submitted to Mumbai University in July 2022
Thesis submitted in Jan 2023, awaiting Final Defence Exam

SYNOPSIS OF THE THESIS TO BE SUBMITTED TO THE UNIVERSITY OF MUMBAI FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) (TECHNOLOGY) IN THE SUBJECT OF ELECTRONICS ENGINEERING

Name of the Student	: Mrs. Kanchan Vivek Chavan
Title of the thesis	: Time Interval Measurement with High Resolution over Wide Dynamic Range for Nuclear Timing Spectroscopy Applications
Degree & Subject	: Doctor of Philosophy (Ph.D.) - (Technology) in Electronics Engineering
Registration No. / Date	: 11/11-12-2017
Name of the Research Supervisor / Guide	: Dr. (Mrs.) Jayalekshmi M. Nair
Date of Superannuation / retirement	: 31/05/2027
Name of the Research Supervisor/ Co-Guide	: Dr. Prakash P. Vaidya
Name of the Research Center	: Vivekanand Education Society's Institute of Technology, Hashu Advani Memorial Complex, Collector's Colony, Chembur, Mumbai-400074, India.
Signature of Student	: Chavan
Signature of Research Supervisors / Guide	: Jayalekshmi Dr. (Mrs.) Jayalekshmi M. Nair
Co-guide	: P. P. Vaidya Dr. Prakash P. Vaidya
Date of submission of Synopsis	: 18 JULY 2022

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Jayalekshmi
Dr. (Mrs.) J. M. Nair
Principal
Vivekanand Education Society's Institute of Technology

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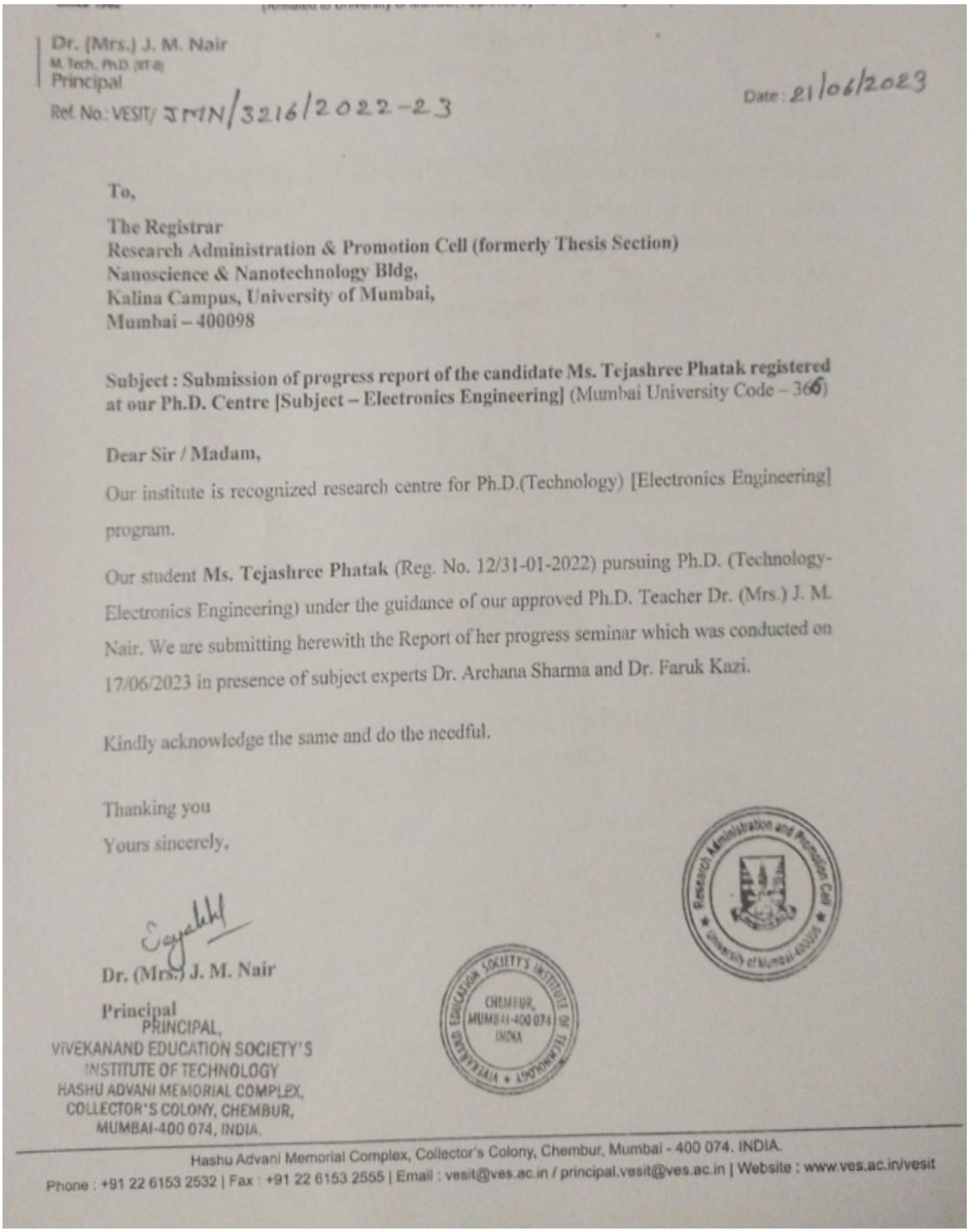

Dr. (Mrs.) J. M. Nair
M.Tech., Ph.D. (IIT-B)
Principal

Ref. No.: VESIT/ JMN/3216/2022-23

Date: 21/06/2023

To,

The Registrar
Research Administration & Promotion Cell (formerly Thesis Section)
Nanoscience & Nanotechnology Bldg,
Kalina Campus, University of Mumbai,
Mumbai – 400098

Subject : Submission of progress report of the candidate Ms. Tejashree Phatak registered at our Ph.D. Centre [Subject – Electronics Engineering] (Mumbai University Code – 366)

Dear Sir / Madam,

Our institute is recognized research centre for Ph.D.(Technology) [Electronics Engineering] program.

Our student **Ms. Tejashree Phatak** (Reg. No. 12/31-01-2022) pursuing Ph.D. (Technology-Electronics Engineering) under the guidance of our approved Ph.D. Teacher Dr. (Mrs.) J. M. Nair. We are submitting herewith the Report of her progress seminar which was conducted on 17/06/2023 in presence of subject experts Dr. Archana Sharma and Dr. Faruk Kazi.

Kindly acknowledge the same and do the needful.

Thanking you
Yours sincerely,

Dr. (Mrs.) J. M. Nair
Principal
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INSTITUTE OF TECHNOLOGY
HASHU ADVANI MEMORIAL COMPLEX,
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MUMBAI-400 074, INDIA.

Research Administration and Promotion Cell
University of Mumbai

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CHEMBUR, MUMBAI-400 074 INDIA

Hashu Advani Memorial Complex, Collector's Colony, Chembur, Mumbai - 400 074. INDIA.
Phone : +91 22 6153 2532 | Fax : +91 22 6153 2555 | Email : vesit@ves.ac.in / principal.vesit@ves.ac.in | Website : www.ves.ac.in/vesit

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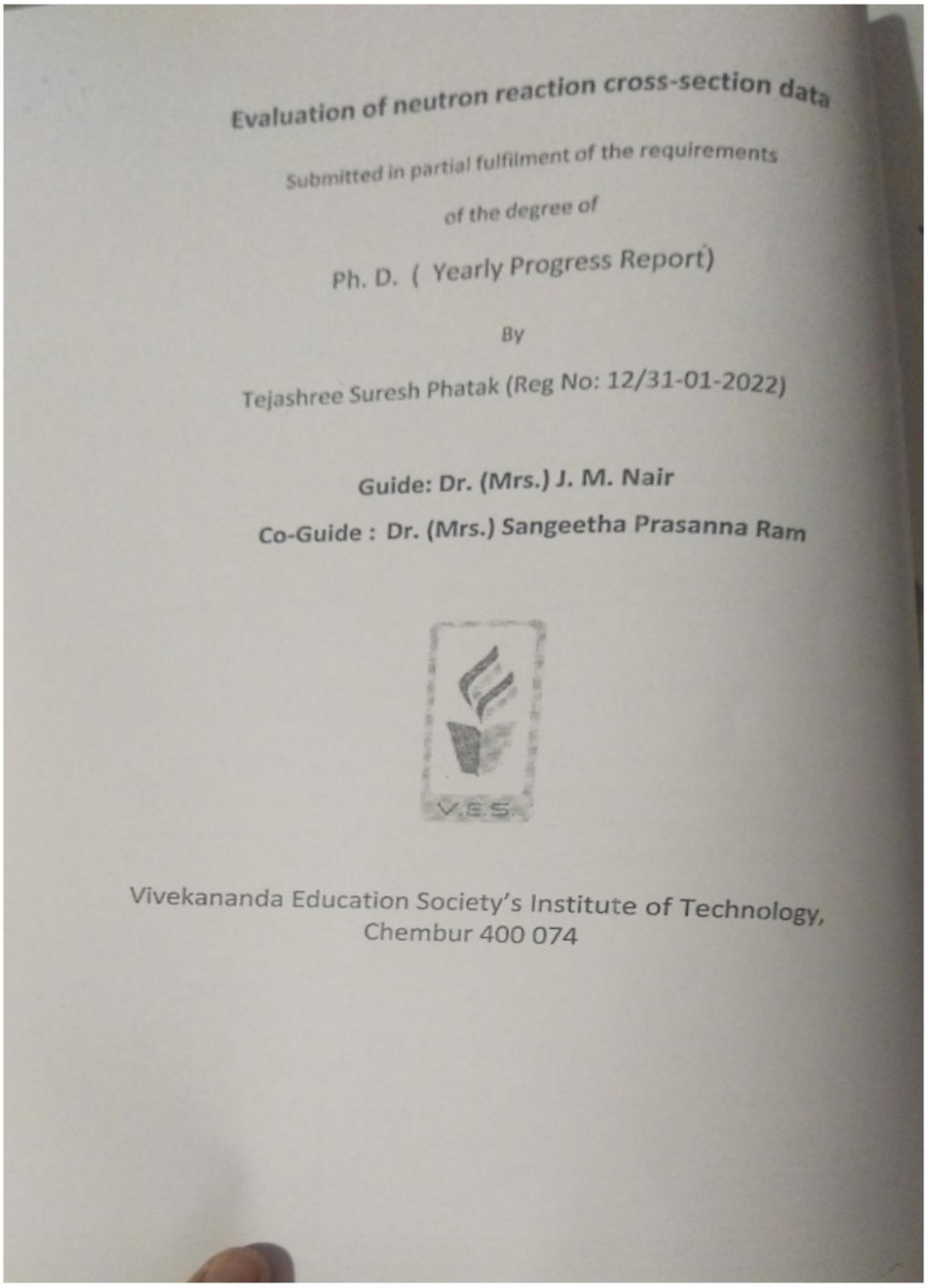

Evaluation of neutron reaction cross-section data

Submitted in partial fulfilment of the requirements

of the degree of

Ph. D. (Yearly Progress Report)

By

Tejashree Suresh Phatak (Reg No: 12/31-01-2022)

Guide: Dr. (Mrs.) J. M. Nair

Co-Guide : Dr. (Mrs.) Sangeetha Prasanna Ram

Vivekananda Education Society's Institute of Technology,
Chembur 400 074

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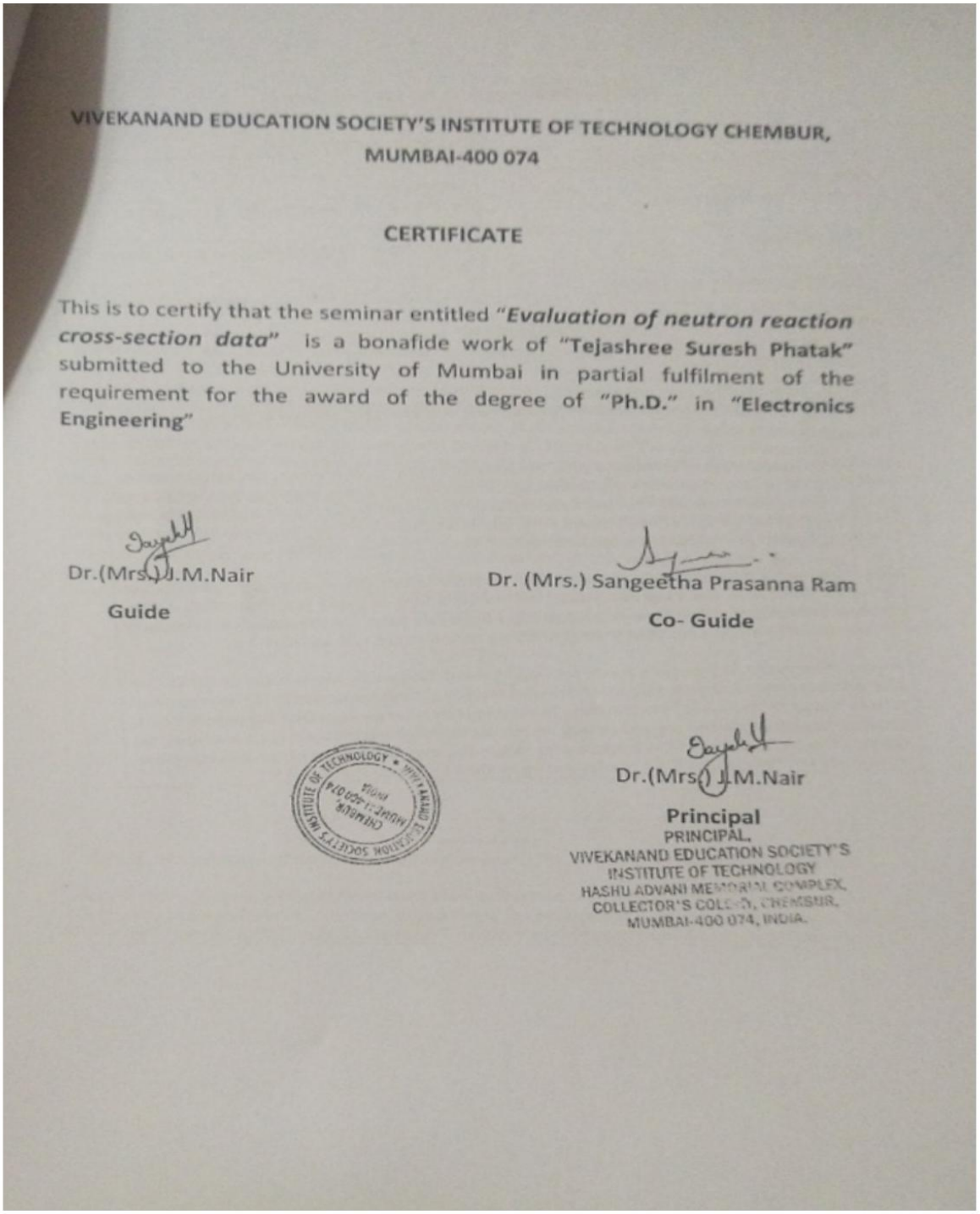

VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY CHEMBUR,
MUMBAI-400 074

CERTIFICATE

This is to certify that the seminar entitled "*Evaluation of neutron reaction cross-section data*" is a bonafide work of "**Tejashree Suresh Phatak**" submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of "**Ph.D.**" in "**Electronics Engineering**"

Dr.(Mrs.) J.M.Nair
Guide

Dr. (Mrs.) Sangeetha Prasanna Ram
Co- Guide

Dr.(Mrs.) J.M.Nair
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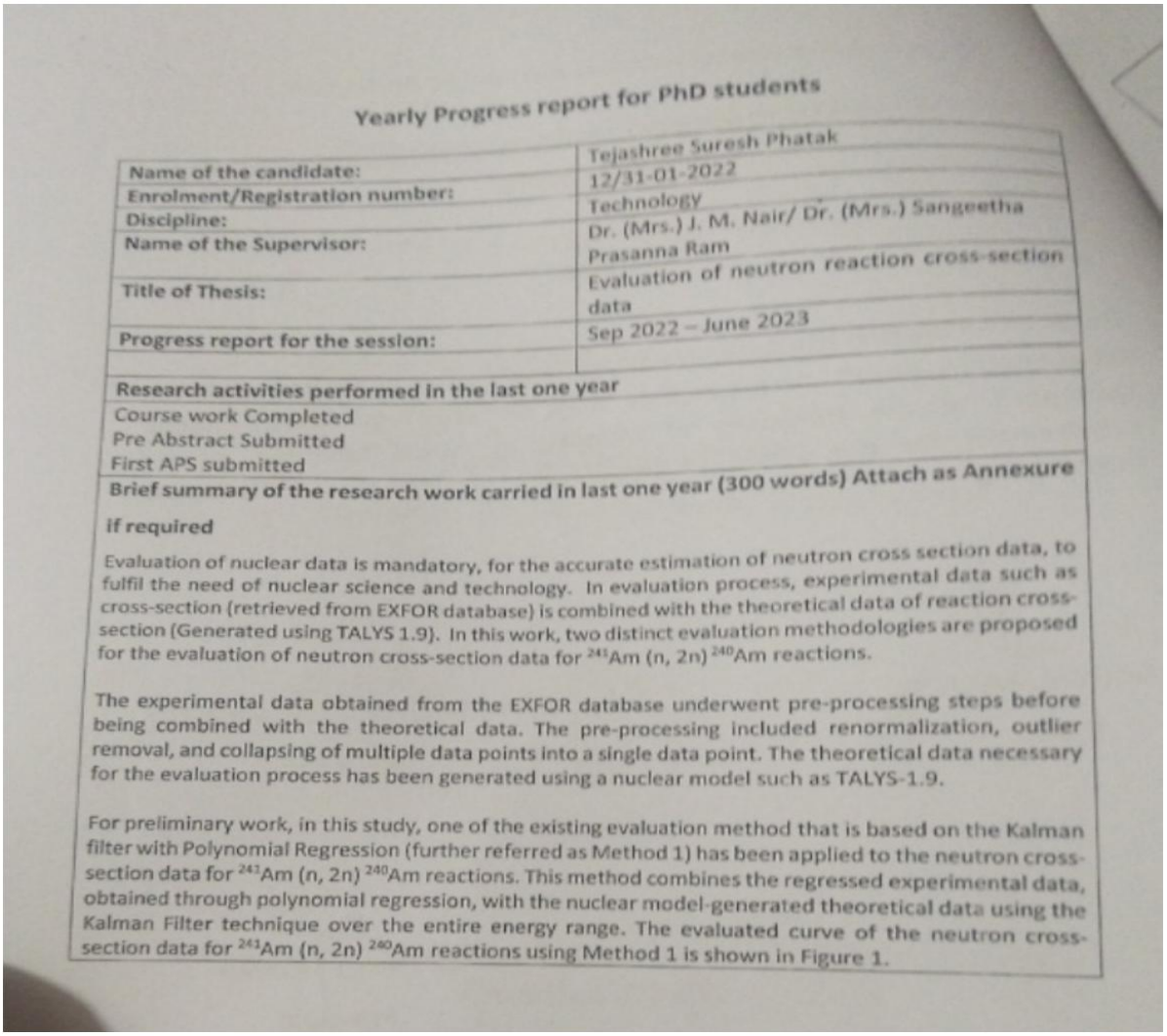

Yearly Progress report for PhD students

Name of the candidate:	Tejashree Suresh Phatak
Enrolment/Registration number:	12/31-01-2022
Discipline:	Technology
Name of the Supervisor:	Dr. (Mrs.) J. M. Nair/ Dr. (Mrs.) Sangeetha Prasanna Ram
Title of Thesis:	Evaluation of neutron reaction cross-section data
Progress report for the session:	Sep 2022 – June 2023

Research activities performed in the last one year

Course work Completed
Pre Abstract Submitted
First APS submitted

Brief summary of the research work carried in last one year (300 words) Attach as Annexure if required

Evaluation of nuclear data is mandatory, for the accurate estimation of neutron cross section data, to fulfil the need of nuclear science and technology. In evaluation process, experimental data such as cross-section (retrieved from EXFOR database) is combined with the theoretical data of reaction cross-section (Generated using TALYS 1.9). In this work, two distinct evaluation methodologies are proposed for the evaluation of neutron cross-section data for ^{241}Am (n, 2n) ^{240}Am reactions.

The experimental data obtained from the EXFOR database underwent pre-processing steps before being combined with the theoretical data. The pre-processing included renormalization, outlier removal, and collapsing of multiple data points into a single data point. The theoretical data necessary for the evaluation process has been generated using a nuclear model such as TALYS-1.9.

For preliminary work, in this study, one of the existing evaluation method that is based on the Kalman filter with Polynomial Regression (further referred as Method 1) has been applied to the neutron cross-section data for ^{241}Am (n, 2n) ^{240}Am reactions. This method combines the regressed experimental data, obtained through polynomial regression, with the nuclear model-generated theoretical data using the Kalman Filter technique over the entire energy range. The evaluated curve of the neutron cross-section data for ^{241}Am (n, 2n) ^{240}Am reactions using Method 1 is shown in Figure 1.

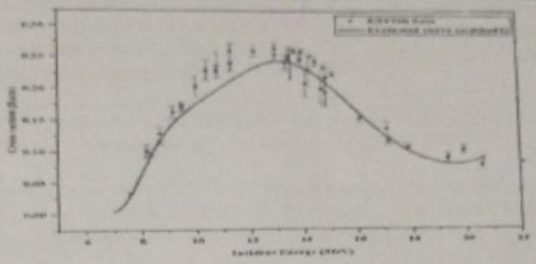

Figure 1 . Evaluated Curve of the neutron cross-section data for ^{241}Am (n, 2n) ^{240}Am reactions using Method 1

Another method being utilizes Gaussian Process Regression (GPR) (Method 2). This method uses Gaussian Process Regression for evaluation over the entire energy range, which is effective in handling uncertainties and capturing complex trends, along with Polynomial Regression for fitting the experimental data. A notable modification introduced in this method is the incorporation of model deficiency. Nuclear evaluators have recently been focusing on addressing model deficiency, which is associated with the data generated by the nuclear model. Nuclear reactions are complex phenomena involving various nuclear physics processes, and accurately capturing all the details within a single model can be challenging. Therefore, it is important to recognize that model-generated nuclear data may deviate from the experimental pattern or underlying physics. This discrepancy between the model-generated data and the theoretical data is referred to as a model deficiency. In this method, model deficiency is quantified using rational quadratic function and incorporated into the evaluation process along with the prior covariance matrix. By considering model deficiency, the evaluation method aims to account for the limitations or discrepancies in the model-generated data, thus improving the reliability and accuracy of the evaluation. The evaluated curve of the neutron cross-section data for ^{241}Am (n, 2n) ^{240}Am reactions using Method 2 is shown in Figure 2.

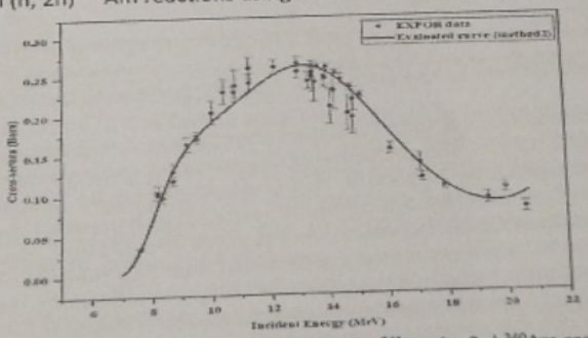

Figure 2 . Evaluated Curve of the neutron cross-section data for ^{241}Am (n, 2n) ^{240}Am reactions using Method 2

For validation of applicability of these evaluation methods to the neutron cross-section data of the fissionable and non-fissionable isotope, evaluation of the neutron cross-section data of ^{232}Th (n, 2n) ^{231}Th and ^{100}Mo (n, 2n) ^{99}Mo was also done. From validation, we can conclude that Evaluation Method

1 and Evaluation Method 2 are data-dependent and therefore cannot be applicable to all types of isotopes. Also, quantified model deficiency in the evaluation using GPR is not uniform over the entire energy range. For validation purpose, evaluated curve of method 1 and method 2 were compared with the standard libraries such as ENDF curve and are shown in Figure 3 and 4 respectively.

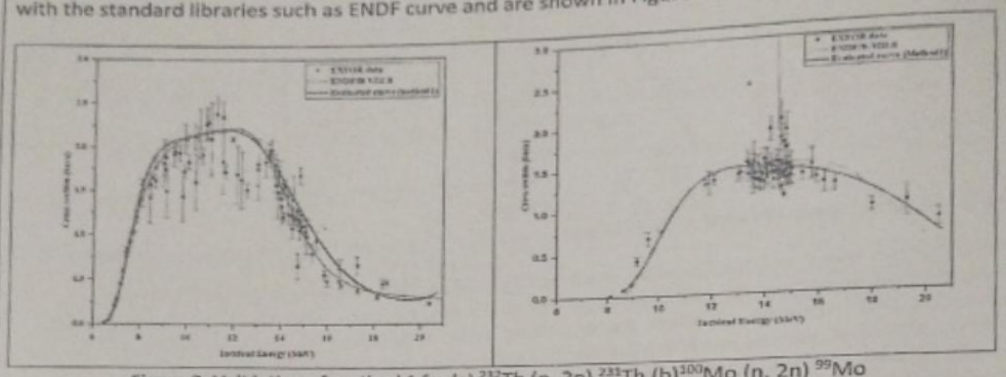

Figure 3. Validation of method 1 for (a) ^{232}Th (n, 2n) ^{231}Th (b)^{100}Mo (n, 2n) ^{99}Mo

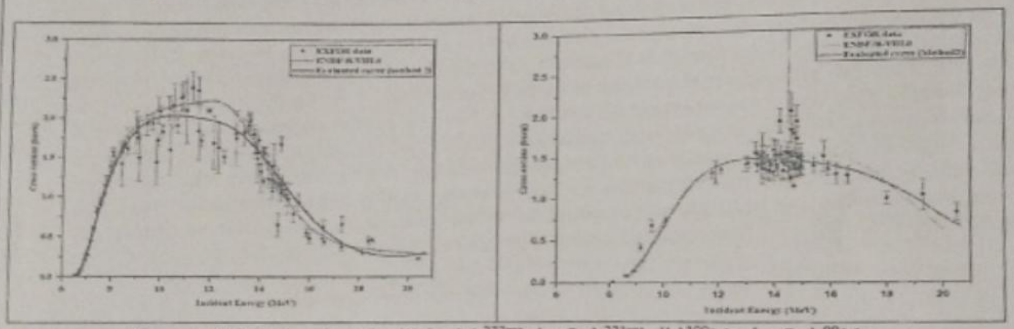

Figure 4. Validation of method 2 for (a) ^{232}Th (n, 2n) ^{231}Th (b)^{100}Mo (n, 2n) ^{99}Mo

Based on this analysis, Piecewise Nuclear Data Evaluation using Cluster based approach (method 3) has been proposed for the first time for the evaluation of neutron cross-section data of ^{241}Am (n, 2n) ^{240}Am reaction. In proposed evaluation Method 3, cluster-based piece-wise evaluation has been proposed. Clusters are formed considering the nonlinear relationship between energy and cross-section, as well as the non-constant model deficiency over the entire energy range. These clusters are based on dataset features found in pre-processed experimental data and theoretical data. A well-known probability-based clustering technique called Gaussian Mixture Model (GMM) has been successfully used to form clusters. Evaluation has been carried out in each cluster independently. The number of clusters varies as per the datasets. Each cluster is subjected to polynomial regression separately. Similar to the clustering of experimental data, the clustering of
model data was done. The model deficiency in each cluster has been quantified. To quantify the model deficiency, chi-square analysis has been used. Then, with the help of the Kalman filtering techniques, evaluation in each cluster, of model generated data with the model deficiency and experimental data

was performed. These evaluated curves from each cluster were then combined using the Savitzky-Golay filter (SG) filter in the evaluation process to ensure the proper merging of evaluated curves from each cluster. The Mean Square Error test was used to assess the efficiency of the smoothened evaluated curve, particularly at cluster borders.

Evaluated curve for neutron cross-section data of ^{241}Am (n, 2n) ^{240}Am reaction generated using method 1, method 2 and method 3 were compared and shown in figure 5.

The evaluated curves generated using Method 3 were compared with various standard libraries such as ENDF/B-VIII.0, JEFF-3.3, JENDL-4.0, BROND-3.1, CENDL-3.1, and TENDL 2021 and shown in figure 5. The comparison revealed that the curves obtained from Method 3 exhibit good agreement with these standard libraries.

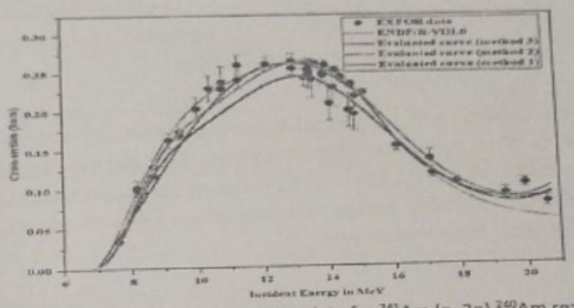

Figure 5 . Evaluated Curve of the neutron cross-section data for ^{241}Am (n, 2n) ^{240}Am reactions using Method 1, Method 2 and Method 3.

Research Papers Published in the refereed journals in last one year with Impact Factor:

1. T. Phatak, J. Nair, S. Prasanna Ram, B. J. Roy, and G. Mohanto, 'Regression analysis of experimental reaction cross-section data of Am(n, 2n)240Am', EPJ Web of Conferences, vol. 284, 05 2023. (0.4)

Research Papers Published in the Conference Proceedings in last one year

2. T. S. Phatak, J. Nair, S. P. Ram, B. J. Roy and G. Mohanto, "Non-Linear Unscented Transformation Techniques for Error Estimation of HPGe Detector Efficiency," 2022 5th International Conference on Advances in Science and Technology (ICAST), Mumbai, India, 2022, pp. 647-653, doi: 10.1109/ICAST55766.2022.10039524.

Research Papers Published in the book chapter

3. Paper entitled "Evaluation of neutron cross-section data of ^{241}Am(n,2n)^{240}Am reaction using Gaussian Process Concept " has been selected in "5th International Conference on Communication and Computational Technologies (ICCCT 2023)" , Springer Book 'Series, Algorithms for Intelligent Systems'. (accepted and in process of publication)

Any other achievements (*Please attach separate sheets if required.*)

It is certified that all information mentioned in the yearly progress report is correct to best of my knowledge.

Date: 19-6-2023

Full Signature of the Applicant

Signature of the Supervisor with Seal

Note: The Annual Progress reports will be placed before the RDC of concern discipline for approval. The report and further recommendation will be kept in the personal file of the candidate. In the case candidate who does not submit the progress report within the stipulated time, the RDC may recommend suitable action, and repletion of such practice might invite cancellation of his/her PhD registration/enrolment.

Comments: Progress in work is satisfactory

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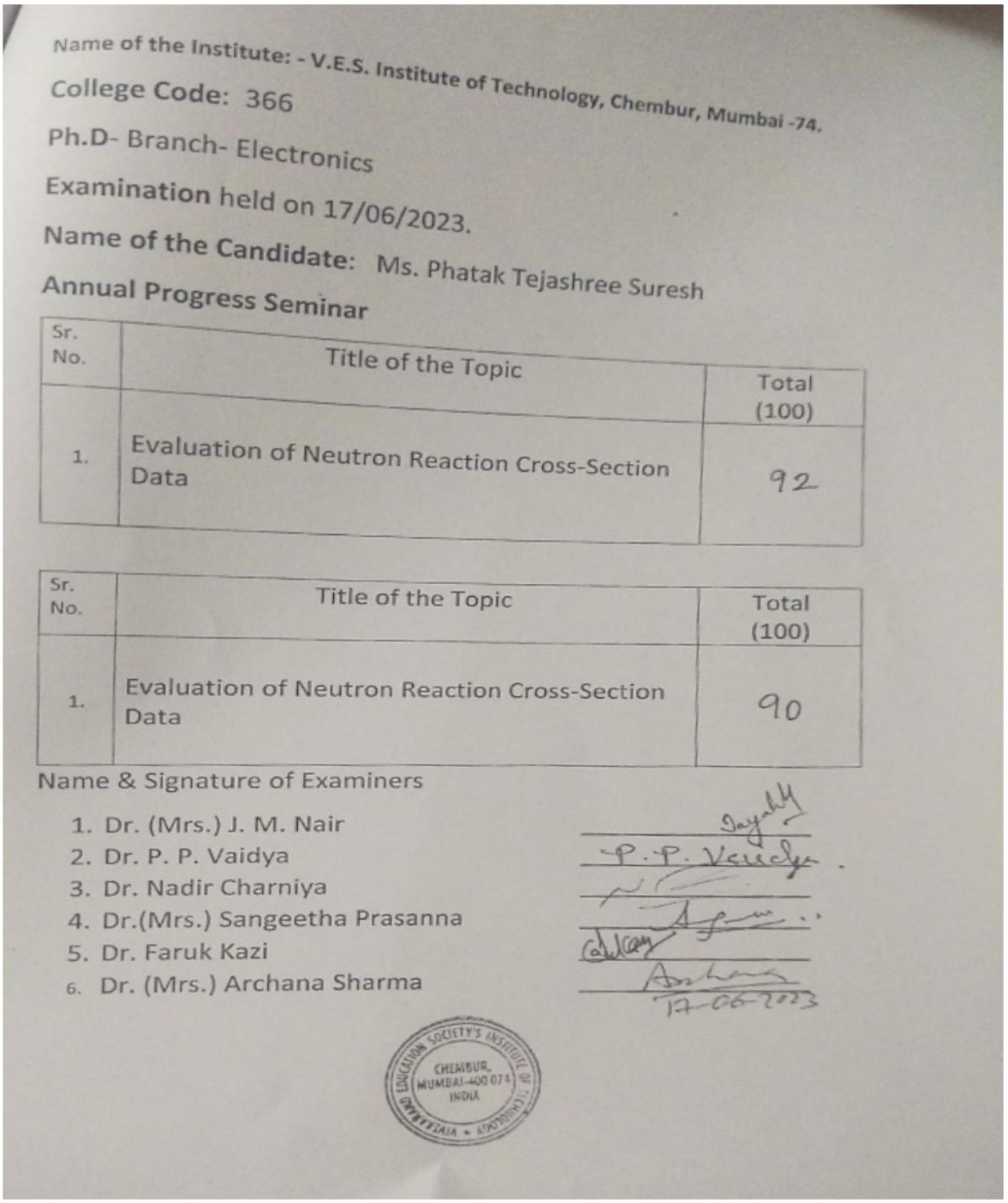

Name of the Institute: - V.E.S. Institute of Technology, Chembur, Mumbai -74.

College Code: 366

Ph.D- Branch- Electronics

Examination held on 17/06/2023.

Name of the Candidate: Ms. Phatak Tejashree Suresh

Annual Progress Seminar

Sr. No.	Title of the Topic	Total (100)
1.	Evaluation of Neutron Reaction Cross-Section Data	92

Sr. No.	Title of the Topic	Total (100)
1.	Evaluation of Neutron Reaction Cross-Section Data	90

Name & Signature of Examiners

1. Dr. (Mrs.) J. M. Nair
2. Dr. P. P. Vaidya
3. Dr. Nadir Charniya
4. Dr.(Mrs.) Sangeetha Prasanna
5. Dr. Faruk Kazi
6. Dr. (Mrs.) Archana Sharma

17-06-2023

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9

Since 1962

Outline of the Research Proposal Submitted for the Degree of Doctor of Philosophy (Tech) in the subject of Electronics.

Title of the proposal

Evaluation of Neutron Reaction Cross-section Data

Name of the Candidate	:	Tejashree Suresh Phatak
Educational Quantification of the candidate :		B.E (Electronics and Telecommunication)
		M.E (Electronics and Telecommunication)
Name and Designation of Research Supervisor :		Dr.(Mrs.) J. M. Nair
		Principal, V.E.S.I.T,
		Chembur –400074
Place of Research Place	:	V.E.S Institute of Technology
		H.A.M,C Collector's Colony
		Chembur, Mumbai-400 0074
Date of Submission of Proposal	:	
Signature of the candidate	:	Phatak
Signature of the Research Supervisor	:	1) Jayalakshmi
		2)

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MUMBAI-400 074, INDIA.