GOVERNMENT OF INDIA
MINISTRY OF TRIBAL AFFAIRS
LOK SABHA
UNSTARRED QUESTION NO- †1698
TO BE ANSWERED ON- 05/12/2024

SEMICONDUCTOR TRAINING FOR TRIBAL STUDENTS

†1698. SHRI GAJENDRA SINGH PATEL:
SHRI P P CHAUDHARY:

Will the Minister of TRIBAL AFFAIRS be pleased to state:

(a) whether there is any scheme to provide basic and advance level semiconductor training to upgrade the skills of tribal students, if so, the details thereof;

(b) the detailed framework and curriculum with duration and eligibility criteria thereof;

(c) the number of tribal students who have received training thereunder during the last three years, State-wise and gender-wise;

(d) whether any collaboration has been established with semiconductor industry partners for providing training and placement opportunities, if so, the details thereof; and

(e) the funds allocated and utilized for these training programmes during the last three years and the placement outcomes thereof?

ANSWER

MINISTER OF STATE FOR TRIBAL AFFAIRS
(SHRI DURGADAS UIKEY)

(a) to (b): Ministry of Tribal Affairs, under the Central Sector Scheme: Tribal Research Information, Education, Communication and Events (TRI-ECE) has entrusted a project "Semiconductor Fabrication & Characterization Training for Students from Tribal Community" to Centre for Nano Science and Engineering, Indian Institute of Science, Bengaluru in 2023-24. The project aims to deliver 2100 NSQF-certified level 6.0 & 6.5 training in Semiconductor Technology to tribal students over three years in collaboration with IISc. Under the project, there is provision of providing basic training to 1500 tribal students and advanced training to 600 tribal students. As informed by IISC, Bengaluru, Ministry of Electronics & Information Technology (MeitY), the detailed framework and curriculum with duration and eligibility criteria are at **Annexure I.**

(c) to (d): Presently, 111 trainees (93 male, 17 female, and 01 transgender) from have received training in the 1st Foundation Program and total 29 trainees (22 male and 7 female) for the 1st Advanced Program on Nano Science and Technology. The program does not have an explicit mandate for placement. However, CeNSE, IISc is working to establish connections with semiconductor industry partners to enhance placement opportunities of the participants

(e): The total cost approved for a project is ₹ 13.02 cr. by the Ministry of Tribal Affairs and an amount of Rs ₹ 2,97,56,648 is presently available with Centre for Nano Science and Engineering, Indian Institute of Science, Bengaluru.

Annexure-I

Annexure referred to in reply to part (a) to (b) of the Lok Sabha Unstarred Question No. †1698 for 05.12.2024 asked by Shri Gajendra Singh Patel and Shri P P Chaudhary, Hon'ble Members of Parliament regarding Semiconductor Training for Tribal Students

The detailed framework and curriculum with duration and eligibility criteria are as under:

The program is offering two courses: foundational and advanced.

SL No	Program Name	Delivery mode	Hours /course	NQR code	NCrF/ NSQF Level	Qualifications of attendees	Number of participants per year
1	Foundation Program on Nano Science And Technology	Online	60	NG-06-EH-00197-2023-V1-ESSC	6	UG Engineering or MSc	500/Year
2	Advanced Program on Nano Science and Technology	Online + Offline	90	NG-6.5-EH-00198-2023-V1- ESSC	6.5	UG Engineering or MSc + Pass the foundational program	200/Year
	Total						**700/year**

Foundation Program on Nano Science and Technology

The program is designed to equip learners with the foundational knowledge of semiconductor technology. The **60-hour training is delivered online.** The foundational program is NSQF-certified, titled "Foundation Program on Nano Science and Technology" . Short description of the course is as follows:

1. Course Description:

This course offers an introductory overview of Nanoelectronics, highlighting ongoing research activities at a designated nano center. Participants will gain insights into the research infrastructure through a series of lectures and application notes, detailing the available equipment and its capabilities. Organized into modules, the lecture series covers key topics such as MEMS/NEMS sensors, microfluidics, compound semiconductor devices, spintronics, 2D materials, photovoltaics, and nanophotonic.

2. Key Modules:

a. This module guides trainees the basic concepts and various processes of nanotechnology/nanoelectronics

b. An overview of the cutting-edge equipment and research infrastructure available at the nano centres, giving participants hands-on exposure.

c. Core lectures on various topics in nanoscience, including foundational principles, emerging technologies, and their applications.

d. Supplementary reading material and assignments designed to reinforce learning and support independent study.

e. Trainees will learn how to develop and write detailed research proposals, an essential skill

f. A platform for trainees to present their research and findings to peers, fostering discussion and collaboration.

g. A final assessment to test participants' knowledge and understanding of the course material.

3. Duration: 60 hours

4. Learning Outcomes:

a. Gain a strong foundation in the basic concepts and processes of nanotechnology and nanoelectronics.

b. Acquire practical exposure to advanced research equipment and infrastructure used in nanotechnology research at nano centres.

c. Understand key topics in nanoscience, including foundational principles, emerging technologies, and their diverse applications.

d. Develop the ability to craft comprehensive research proposals, preparing for future academic or industry-related projects.

5. Eligibility:

Minimum Educational Qualification and Experience- Pursuing 4th year of UG – Engineering in the relevant field or Pursuing first year of M.Sc in the relevant field

6. Module: Detailed curriculum details module wise :

Module Details	**Duration (Hours)**	**Terminal outcomes**	**Execution Details**
Module 1 (Literature survey)	10:00	Explain the basic concepts of nanotechnology/ nanoelectronics Describe various processes in nanotechnology/ nanoelectronics	Pre-recorded NPTEL lectures were sent to students. For details, refer Appendix. The lectures were on the following topics Introduction to micro-fabrication Substrate Cleaning Additive processing: Doping Additive processing: Native Films Additive processing: CVD Additive processing: PVD Lithography 1 Lithography 2 Subtractive Process: Wet Etching Subtractive Process: Dry Etching CMP and Packaging
Module 2 (Introduction to the Facilities)	03:00	Awareness about various facilities available at IISc Tool capabilities and specifications	Online Lectures. See schedule in Appendix
Module 3 (Lecture on Nanoscience	20:00	Concepts in nanoscience and engineering	Online Lectures. See schedule in Appendix

and Engineering)			
Module 4 (HW/Reading material)	15:00	Basic understanding of Nanotechnology/ Nanoelectronics Basic understanding of Semiconductor Technology	Students worked on projects from home. Students could select from a range of topics. They could also define their own projects. Details in Appendix.
Module 5 (Research Proposal preparation)	05:00	Gaining knowledge on how to submit good technical proposals.	Students submitted a project report, based on their project.
Module 6 (Participant Poster presentations)	06:00	Summarizing a R&D proposal in a concise form Platform to show-case the proposed research work to reviewers and participants. Technical discussions which will lead to improvise the research problem	Students made a presentation on the project.
Module 7 (MC Quiz)	01:00	Enhancing the technical aptitude Assessment of the understanding the concepts taught during the lectures	Online testing platform. See appendix.
Total Duration	60:00		

Advanced Program on Nano Science and Technology:

The program is designed to equip learners with the advanced knowledge of semiconductor technology. The 90-hour training is delivered online and offline**.** The details of the course are as follows.

1. **Course Description:**

This course offers immersive, hands-on experience in nanoelectronics research and semiconductor fabrication processes. The trainees will explore state-of-the-art research infrastructure at Nano Centers through lab tours, hands-on training, and expert-led sessions. The training covers both fabrication and characterization tools such as lithography, thin films, XRD, AFM, SEM, and simulations like TCAD and COMSOL. Additionally, trainees will engage in literature review, research proposal preparation, and self-assess their learning through an interactive quiz.

2. **Key Modules:**

a. Trainees will be introduced to the cutting-edge research infrastructure at Nano Centres through lab tours, highlighting the equipment and processes in use.

b. Practical training on essential semiconductor fabrication steps such as lithography, thin films, dry and wet etching, and metal deposition.

c. In-depth training on tools like AFM, SEM, XRD, Raman, and TEM, providing insights into the analysis and measurement techniques in nanoelectronics.

d. Study of relevant literature to deepen understanding of fabrication and characterization processes, supplemented by guided homework assignments.

e. Trainees will develop a research proposal based on the knowledge acquired from hands-on sessions and literature review.

f. Trainees will present their research proposals to a technical committee, receiving feedback and engaging in discussions to refine their research ideas.

3. **Duration : 90 hours**
4. **Learning Outcomes:**

a. Develop a thorough understanding of the research infrastructure at Nano Centres, including hands-on experience with advanced fabrication and characterization tools.

b. Gain practical knowledge of semiconductor fabrication processes such as RCA cleaning, deposition, lithography, etching, doping, and packaging techniques.

c. Acquire proficiency in using various characterization tools for electrical, mechanical, optical, and material analysis, including IV/CV measurements, XRD, SEM, Raman, AFM, and TEM.

d. Enhance the ability to critically review relevant scientific literature and apply this knowledge to novel devices and processes in nanoelectronics.

e. Master the skills of writing a clear and impactful research proposal, addressing problem statements and outlining innovative concepts with a solid proof of concept.

5. **Eligibility:**

Minimum Educational Qualification and Experience- Pursuing First year of PG Engineering in the relevant field OR M.Sc in relevant field

**Basic knowledge of Nano Science required

6. **Modules**

Detailed curriculum module wise :

NOS and Module Details	**Theory Duration (In Hours)**	**Practical/OJT Duration (In Hours)**	**Total Duration (In Hours)**	**Execution Details**
Module 1 (Introduction to Facilities/ Equipment)	03:00	06:00	09:00	In-person lectures were delivered on the IISc campus by faculty members.
Module 2 (Hand-on training on	06:00	16:00	22:00	Lab sessions at the National Nanofabrication Centre exposed

Fabrication modules)				trainees to fabrication processes, including RCA cleaning, doping, Raman/XRD/Solar Simulator, SEM, XPS, lithography, and aluminium deposition. [Detailed information provided in the appendix]
Module 3 (Hands-on training on Characterization tools)	00:00	10:00	10:00	Lab sessions at the Micro Nano Characterization Facility allowed trainees to work with tools such as the Atomic Force Microscope, Micro System Analyzer 500, probe station, electromagnet, and gas sensors.
Module 4 (HW/Reading material)	00:00	10:00	10:00	Online video links and handouts were provided for additional learning.
Module 5 (Preparation of Research Proposal)	06:00	10:00	16:00	Trainees submitted project reports based on nanotechnology-related topics.
Module 6 (Research Proposal presentation)	02:00	10:00	12:00	Trainees without prior experience developed technical presentations (up to five slides) for the Level 2 Advanced Training Program, highlighting the fabricated device and key learning outcomes.
Module 7 (MC Quiz)	01:00	10:00	11:00	A proctored physical exam was conducted in the examination hall, with questions focusing on the hands-on sessions at the Characterization Facility and Fabrication Centre.
Total Duration	18:00	72:00	90:00	

*****