Inverse Problems and Signal Processing in Non-Destructive Evaluation
(November 23-27, 2022)

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Overview

Non-destructive testing (NDT) is a technique used in industry to analyze the qualities of a material, component, structure, or system for characteristic variations, welding faults, and discontinuities without causing damage to the original part. It is a highly valuable technique that can save both money and time in product evaluation, troubleshooting, and research while maintaining its integrity. The most frequently used NDT methods are Ultrasonic, Radiographic, Eddy-current, Magnetic-particle, liquid penetrant, Visual testing, Microwave/Millimeter wave technique and Terahertz wave techniques. NDT is commonly used in Forensic Engineering, Mechanical Engineering, Petroleum Engineering, Electrical and Electronics Engineering, Civil Engineering, Systems Engineering, Aeronautical Engineering, Medicine, and arts. Innovations in the field of nondestructive testing have profoundly impacted medical functional imaging, including echocardiography, medical ultrasonography, and digital radiography. Various national and international trade associations exist to promote the industry, knowledge about non-destructive testing, and to develop standard methods and training. These include the American Society for Nondestructive Testing, the Non-Destructive Testing Management Association, the International Committee for Non-Destructive Testing, the European Federation for Non-Destructive Testing, the British Institute of Non-Destructive Testing, and Indian Society for Non-Destructive Testing. NDT methods rely upon the use of electromagnetic radiation, sound, and other signal conversions to examine a wide variety of articles (metallic and non-metallic, food-product, artefacts and antiquities, infrastructure) for integrity, composition, or condition with no alteration of the article undergoing examination.

An inverse problem is a broad framework for converting observed measurements into knowledge about a physical item or system of interest. Inverse problems are among the most significant mathematical problems (Signal processing) in science and mathematics because they provide information on factors that we cannot perceive directly. Inverse issues in Non-Destructive Evaluation necessitate analytical formulation and signal processing (image processing) approaches with statistics. Machine learning algorithms and NDE 4.0 and 5.0.

Objectives

- Exposing the participants to the Inverse problem in NDE and Analytical methods.
- Understanding the data interpretation, Signal, and Image processing in NDE.
- To know how to extract the features using ML and AI.
- To know how to apply the prognosis and statistical methods in NDE.
- To select the NDT method for applications.
- NDE 4.0 and 5.0

Modules	**Each Lecture is of 2 hours** **Day1: 23 Nov 2022** **Lecture 1 (10:00 AM)**: Introduction to NDE Inverse problems. Analytical methods. **Lecture 2 (02:30 PM):** Introduction to NDE Signal Processing. **Day 2: 24 Nov 2022** **Lecture 3 (10:00 AM):** Signal and Image formation and enhancement in NDE. **Lecture 4 (02:30 PM):** NDE data interpretation and processing: signal classification, defect reconstruction. MATLAB Examples: Data Processing. **Day 3: 25 Nov 2022** **Lecture 5 (10:00 AM):** Data analysis: Feature extraction and selection – FFT, WT, PCA, ICA **Lecture 6 (02:30 PM):** Data analysis: Machine Learning, AI, e.g., NN, Clustering, SVM. MATLAB examples Data Analysis, Pattern Recognition **Day 4: 26 Nov 2022** **Lecture 7 (10:00 AM):** Model-based inversion techniques. **Lecture 8 (02:30 PM):** Prognosis and statistical methods in NDE. **Day 5: 27 Nov 2022** **Lecture 9 (10:00 AM):** Comparison of the NDE data processing techniques. Selection of the NDT method for particular applications. **Lecture 10 (02:30 PM):** Emerging applications and Future focus, Composite materials NDE and Applications; NDE 4.0 and 5.0
You Should Attend If…	▪ You are a student (B.Tech./M.Sc./M.Tech./Ph.D.) and aspiring researcher within the broad domain of Non-destructive Testing & Evaluation. ▪ You are an Executive/engineer or researcher from manufacturing, service and government organizations including R&D laboratories. ▪ You are Faculty and staff from reputed academic institutions and technical institutions.
Fees	The participation fees per person for attending the course are as follows: **Participants from abroad: US $400** **Industry/ Research Organizations: ₹10,620/- (GST included)** **Academic Institutions:** **Students: ₹ 2950/- (For students attending online ₹1770/- only)** **Non-Students: ₹4720/- (For Non-Students attending online ₹3540/- only)** ***If you are registering for the course "Principles and Modeling of Electromagnetic Non-Destructive Evaluation)" from November 18-22, 2022.*** **Participants from abroad: US $ 600** **Industry/ Research Organizations: ₹14,160/- (GST included)** **Academic Institutions:** **Students: ₹4720/- (For students attending online ₹2950/- only)** **Non-Students: ₹7080/- (For Non-Students attending online ₹5310/- only)** The above fees include all instructional materials, computer use for tutorials, and free internet facility. A limited number of single-bedded shared accommodation requests can be considered from participants which, if allotted, would be on an

	additional payment basis.

The faculty

Prof. Yiming Deng is an Associate Professor in the Nondestructive Evaluation Laboratory, Department of Electrical and Computer Engineering of the College of Engineering, at Michigan State University, USA. Prof. Deng is an Associate Editor of IEEE Transactions on Reliability (IEEE TREL), IEEE Transactions on Magnetics (IEEE TMAG), Research in Nondestructive Evaluation (RNDE), Materials Evaluation (ME), Journal of Prognostics and Health Management (JPHM).

Prof. Deng is an Subject Editor of Nondestructive Testing and Evaluation (Taylor & Francis) and Editorial Board Member of Scientific Reports (Nature). He serves as Panelist and Reviewer for National Science Foundation (NSF), US Department of Energy (DOE), US Department of Transportation (DOT), US Department of Defense (DOD), Canada Natural Sciences and Engineering Research Council (NSERC) and over 40 scientific journals. He is a Senior Member of IEEE and a member of ASNT. He is a Fellow of AGE. Dr Deng's research interests include electromagnetic and acoustic nondestructive evaluation (NDE), structural health monitoring (SHM) for multi-scale, multi-resolution, and multi-parameter damage diagnosis and prognosis; applied electromagnetics and acoustics, and computational modeling. His research work has been extensively supported by federal agencies for the development of novel NDE/SHM actuators and sensors, sensing systems that involve multi-physics simulations for understanding the physics, experimental validation and verification (V&V), as well as actuators/sensors prototyping and fabrication for a wide range of engineering applications to assure safety-critical defense, energy and transportation infrastructure safety, security, durability, reliability and sustainability. Dr. Deng's research has been supported by NSF, DOT, PHMSA, DOE, DoD, NIH, ASNT, NJH and private industries.

Dr Neeraj Rao is an Assistant Professor with the Department of Electronics and Communication Engineering,

Visvesvaraya National Institute of Technology, Nagpur, India. He completed the Bachelor of Engineering (B. Engg.) degree in Electronics and Communication Engineering from Government Engineering College, Jabalpur, India in 2009 and a master's and PhD in Electronics and Communication from Indian Institute of Information Technology Design and Manufacturing Jabalpur, India in 2011 and 2017. His current research interests include Microwave NDT and Antennas.

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Prof. Kishor Bhurchandi is Professor with the Department of Electronics and Communication Engineering, Visvesvaraya National Institute of Technology, Nagpur, India. He did his B.E. and M.E. (Electronics) from SGGSIET, Nanded in 1990 and 1992, Ph.D. from VRCE (VNIT) Nagpur in 2002. He has published more than 80 research papers including 25 SCI indexed research papers including IEEE Transactions. He has authored a book on Advanced Microprocessors and peripherals for McGraw Hill. He got the selected author recognition from McGraw Hill for selling around 4,50,000 copies of the book. He has got five patents published to his credit out of which two are awarded. He was Principal Investigator of three research Projects including one on Face recognition funded by BRNS and a center of excellence on 'COMMBEDDED SYSTEMS' a hybrid of communication and Embedded systems at VNIT Nagpur. He is currently a Professor at Department of Electronics and Communication Engineering at VNIT Nagpur. He is also coordinating the programs like Visvesvaraya Ph.D. Scheme and GIAN at VNIT worth around 16 Crores. He is chairing the committee for setting up a SIEMENS Center of Excellence on Advanced Technologies at VNIT worth Rs 188crores. He is also Chairman of the currently under set up Center for Artificial and Machine Intelligence (CAMI) at VNIT worth INR 1 Crore. His areas of interest include Image processing and computer vision, wavelets, man machine interface, learning, Embedded Systems, Internet of things.

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Visvesvaraya National Institute of Technology, Nagpur

Visvesvaraya National Institute of Technology, Nagpur is one of the thirty-one National Institutes of Technology in the country. The Govt. of India conferred on the Institute, the Deemed to be University status (under University Grants Commission Act, 1956 (3 of 1956)) with effect from 26th June 2002. Subsequently, the Central Govt. by Act of Parliament (National Institutes of Technology Act, 2007 (29 of 2007)) declared VNIT Nagpur as an Institute of National Importance along with all former regional engineering colleges. The Act was brought into force from 15th August 2007. Earlier, the Institute was known as Visvesvaraya Regional College of Engineering (VRCE). It was established in the year 1960 under the scheme sponsored by Govt. of India and Govt. of Maharashtra. The college was started in June 1960 by amalgamating the State Govt. Engineering College functioning at Nagpur since July 1956. In the meeting held in October 1962, the Governing Board of the College resolved to name it after the eminent engineer, planner, and statesman of the country Sir M. Visvesvaraya.

Department of Electronics and Communication Engineering

The department of Electronics and Computer Science was created in 1994 by the department of Electrical Engineering. Later, the Department of Electronics and Communication Engineering has been created in May 2014. Department of ECE offers B.Tech. in Electronics and Communication Engineering, M.Tech. in Communication System Engineering, and PhD. The department has well-qualified and well-motivated faculty members and support staff. There are more than 30 full-time PhD students enrolled in the different areas of RF and Microwave, Antennas, signal and image processing, medical image analysis, embedded system design, communication system, etc. Department has a Centre of Excellence in Combedded Systems and a Centre for Artificial Intelligence. The department is actively involved in R&D as well as consultancy projects and has collaborations with several industries, academic institutions and R&D organizations in the country and outside.