STRUCTURAL HEALTH MONITORING

CVL 864 (2-0-2)

SLOT AD (Tu, Thu: 3:30-5:00 PM)

http://web.iitd.ac.in/~sbhalla/cvl864.htm

Course Instructor: Dr. S. BHALLA (Office V 102)

Course channel:

https://www.facebook.com/groups/cvl864

Consulting hours:

Walk-in:12 to 1 pm (working days)

Online: Course group WhatsApp

OBJECTIVES

To make the student familiar with the state-of-the art in **structural health monitoring** (SHM), both in theory and practice.

To impart working practical skills in SHM.

To prepare the student undertake further R&D studies in SHM.

LECTURE OUTLINE

TOPIC	NO. OF WEEKS
Introduction to SHM	01
Sensor systems and requirements	01
Global and dynamic techniques of SHM	01
Computational and experimental aspects of global dynamic techniques	02
Piezoelectric materials and other smart materials	01
Electro-Mechanical Impedance (EMI) technique	02
Mechanical Impedance approach and relevance to SHM	01
Integration of global and EMI techniques	01
Low cost adaptations and other practical aspects of EMI technique	01
Fatigue life assessment	01
Non-Destructive Evaluation (NDE) Techniques	01
Colloquium	01

LABORATORY

EXPERIMENT	NO. OF SESSIONS
Introduction to various sensor types for SHM	01
Installation of sensors on structures, sensor diagnostics	02
Natural frequency and mode shape extraction	02
Location and quantification of damage using global dynamic techniques	03
SITE VISIT : SHM SYSTEM OF SIGNATURE BRIDGE (SUBJECT TO COVID SITUATION)	**01**
Damage detection using EMI technique	01
Analysis of free piezo-signatures	01
Impedance based identification for SHM	01
Low-cost adaptation of EMI technique	01
Make up lab (for any missed/ repeat work)	01

LABORATORY

HOW TO WRITE REPORT???

FOLLOW THE STYLE OF ANY PUBLISHED PAPER (JOURNAL/ CONFERENCE)

SHOULD HAVE ABSTRACT, INTRODUCTION, CONCISE METHODOLOGY (WITH REFERNCES), RESULTS AND CONCLUSIONS.

ABSTRACT SHOULD PROVIDE OVERALL PICTURE- OBJECTIVES, METHODOLOGY AND CONCLUSIONS.

PAGE LIMIT : PREFERABLY TWO (MAX 4) PRINTED PAGES

COURSE EVALUATION

COMPONENT	MARKS
MINOR 1	15
MINOR 2	15
MAJOR	30
LABORATORY	30
COLLOQUIM	5
ATTENDANCE	5
TOTAL	100

STRUCTURAL HEALTH MONITORING

CVL 864 (2-0-2)

http://web.iitd.ac.in/~sbhalla/cvl864.htm

Course Instructor: Dr. S. BHALLA

Lecture: Tue, Thu (10-11 AM)

Practical: Wed 10:00AM-12:00 PM V 211/216

KEY REFERENCES

Bhalla, S., Moharana, S., Talakokula, V. and Kaur, N. (2017), Piezoelectric Materials: Applications in SHM, Energy Harvesting and Biomechanics, Ane Books Pvt. Ltd. (Indian Edition)

Ewins, D. J. (2000), Modal Testing: Theory, Practice and Applications, 2nd edition, Research Studies Press Ltd., Baldock.

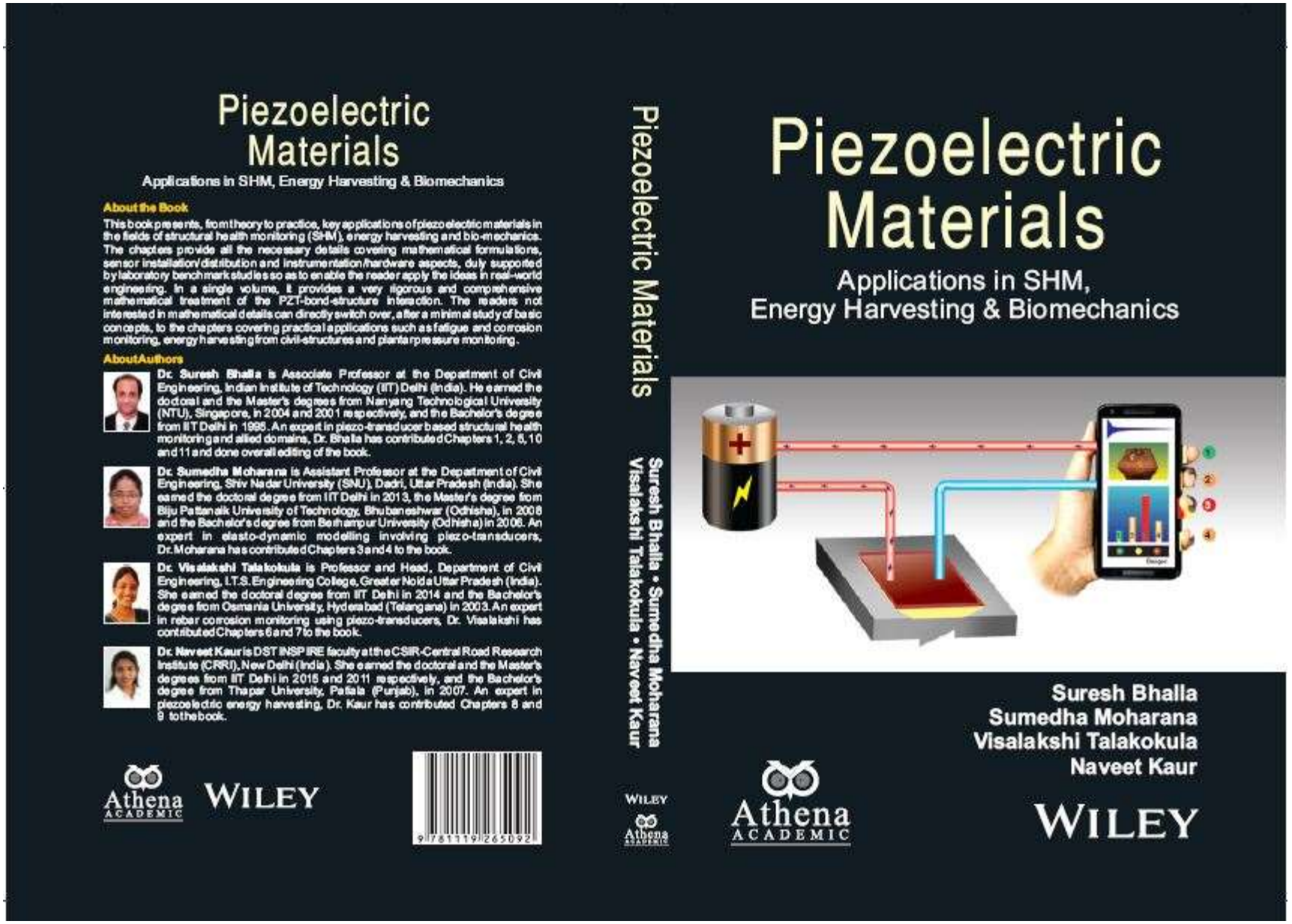
Inman, D. J., Farrar, C.R., Steffan, V. and Lopes, V. (2005), Damage Prognosis -For Aerospace, Civil and Mechanical Systems, John Wiley & Sons, Ltd., Chichester, UK.

Soh, C. K, Yang Y. W. and Bhalla S. (2012), Smart Materials in Structural Health Monitoring, Control and Bio – mechanics, Springer, ISBN: 978-3-642-24462-9 (Print) 978-3-642-24463-6 (Online).

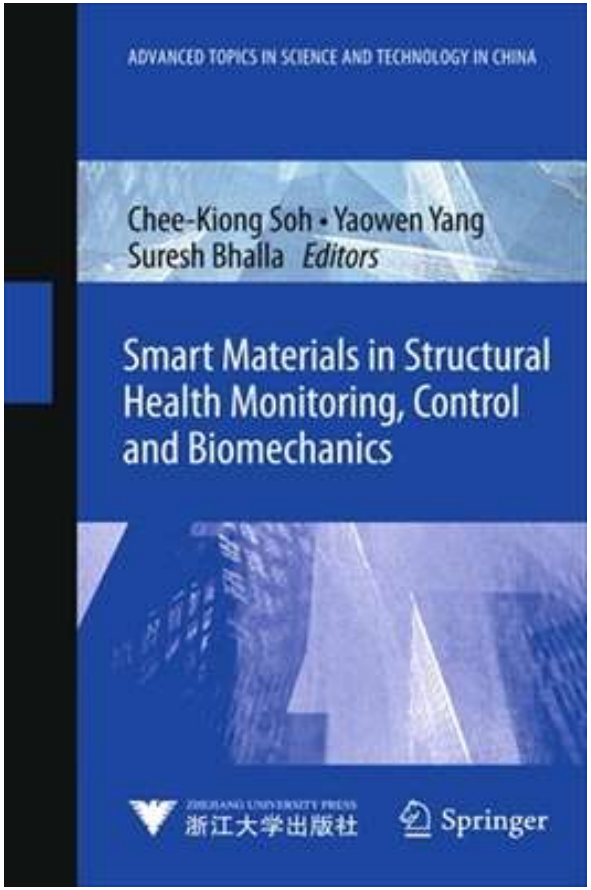
Hixon, E.L. (1988), "Mechanical Impedance", Shock and Vibration Handbook, edited by C. M. Harris, 3rd ed., Mc Graw Hill Book Co., New York, pp. 10.1-10.46.

Ikeda, T. (1990), Fundamentals of Piezoelectricity, Oxford University Press, Oxford.

REFERENCES


Piezoelectric Materials
Applications in SHM, Energy Harvesting & Biomechanics
About the Book
This book presents, from theory to practice, key applications of piezoelectric materials in the fields of structural health monitoring (SHM), energy harvesting and bio-mechanics. The chapters provide all the necessary details covering mathematical formulations, sensor installation/distribution and instrumentation/hardware aspects, duly supported by laboratory benchmark studies so as to enable the reader apply the ideas in real-world engineering. In a single volume, it provides a very rigorous and comprehensive mathematical treatment of the PZT-bond-structure interaction. The readers not interested in mathematical details can directly switch over, after a minimal study of basic concepts, to the chapters covering practical applications such as fatigue and corrosion monitoring, energy harvesting from civil-structures and plantar pressure monitoring.
About Authors
Dr. Suresh Bhalla is Associate Professor at the Department of Civil Engineering, Indian Institute of Technology (IIT) Delhi (India). He earned the doctoral and the Master's degrees from Nanyang Technological University (NTU), Singapore, in 2004 and 2001 respectively, and the Bachelor's degree from IIT Delhi in 1995. An expert in piezo-transducer based structural health monitoring and allied domains, Dr. Bhalla has contributed Chapters 1, 2, 5, 10 and 11 and done overall editing of the book.
Dr. Sumedha Moharana is Assistant Professor at the Department of Civil Engineering, Shiv Nadar University (SNU), Dadri, Uttar Pradesh (India). She earned the doctoral degree from IIT Delhi in 2013, the Master's degree from Biju Pattanaik University of Technology, Bhubaneshwar (Odhisha), in 2008 and the Bachelor's degree from Berhampur University (Odhisha) in 2006. An expert in elasto-dynamic modelling involving piezo-transducers, Dr. Moharana has contributed Chapters 3 and 4 to the book.
Dr. Visalakshi Talakokula is Professor and Head, Department of Civil Engineering, I.T.S. Engineering College, Greater Noida Uttar Pradesh (India). She earned the doctoral degree from IIT Delhi in 2014 and the Bachelor's degree from Osmania University, Hyderabad (Telangana) in 2003. An expert in rebar corrosion monitoring using piezo-transducers, Dr. Visalakshi has contributed Chapters 6 and 7 to the book.
Dr. Naveet Kaur is DST INSPIRE faculty at the CSIR-Central Road Research Institute (CRRI), New Delhi (India). She earned the doctoral and the Master's degrees from IIT Delhi in 2015 and 2011 respectively, and the Bachelor's degree from Thapar University, Patiala (Punjab), in 2007. An expert in piezoelectric energy harvesting, Dr. Kaur has contributed Chapters 8 and 9 to the book.
Athena ACADEMIC
WILEY
9781119265092
Piezoelectric Materials
Suresh Bhalla • Sumedha Moharana
Visalakshi Talakokula • Naveet Kaur
WILEY
Athena ACADEMIC
Piezoelectric Materials
Applications in SHM, Energy Harvesting & Biomechanics
Suresh Bhalla
Sumedha Moharana
Visalakshi Talakokula
Naveet Kaur
Athena ACADEMIC
WILEY

REFERENCES


ADVANCED TOPICS IN SCIENCE AND TECHNOLOGY IN CHINA
Chee-Kiong Soh • Yaowen Yang
Suresh Bhalla Editors
Smart Materials in Structural Health Monitoring, Control and Biomechanics
浙江大学出版社
Springer

OTHER REFERENCES

Aktan, A. E., Helmicki, A. J. and Hunt, V. J. (1998), "Issues in Health Monitoring for Intelligent Infrastructure", Smart Materials and Structures, Vol. 7, No. 5, pp. 674-692.

Aktan, A. E., Catbas, F. N., Grimmelsman, K. A. and Tsikos, C. J. (2000), "Issues in Infrastructure Health Monitoring for Management", Journal of Engineering Mechanics, ASCE, Vol. 126, No. 7, pp. 711-724.

Avitable, P. (2001), "Experimental Modal Analysis (A Simple Non-mathematical Presentation) " http://macl.caeds.eng.uml.edu/umlspace/mspace.html

Bhalla, S., Gupta, A., Bansal, S. and Garg, T. (2009), "Ultra Low Cost Adaptations of Electro-mechanical Impedance Technique for Structural Health Monitoring", Journal of Intelligent Material Systems and Structures, Vol. 20, No. 8 (May), pp. 991-999, DOI: 10.1177/1045389X08100384

Bhalla, S., Yang, Y. W., Zhao, J. and Soh, C. K. (2005), "Structural Health Monitoring of Underground Facilities- Technological Issues and Challenges", Tunnelling and Underground Space Technology ,Vol. 20, No. 5 (September), pp. 487-500.

Bhalla, S. and Soh C. K. (2004), "Structural Health Monitoring by Piezo-Impedance Transducers. Part I Modeling", Journal of Aerospace Engineering, ASCE, Vol. 17, No. 4 (October), pp. 154-165.

Bhalla, S. and Soh C. K. (2004), "Structural Health Monitoring by Piezo-Impedance Transducers. Part II Applications", Journal of Aerospace Engineering, ASCE Vol. 17, No.4 (October), pp. 166-175.

Bhalla, S. and Soh C. K. (2004), "High Frequency Piezoelectric Signatures for Diagnosis of Seismic/ Blast Induced Structural Damages", NDT &E International, Vol. 37, No. 1 (January), pp. 23-33.

Bhalla, S. and Soh C. K. (2003), "Structural Impedance Based Damage Diagnosis by Piezo-Transducers", Earthquake Engineering and Structural Dynamics, Vol. 32, No. 12 (October), pp. 1897-1916.

OTHER REFERENCES

Bhalla, S. and Soh C. K. (2003), "Structural Impedance Based Damage Diagnosis by Piezo-Transducers", Earthquake Engineering and Structural Dynamics, Vol. 32, No. 12 (October), pp. 1897-1916.

Brownjohn, J. M. W., Moyo, P. Omenzettor, P. and Lu, Y. (2003), "Assessment of Highway Bridge Upgrading by Dynamic Testing and Finite-Element Model Updating", Journal of Bridge Engineering, ASCE, Vol. 8, No. 3, pp. 162-172.

Farrar, C. R. and Jauregui, D. A. (1998), "Comparative Study of Damage Identification Algorithms Applied to a Bridge: I. Experiment", Smart Materials and Structures, Vol. 7, No. 5, pp. 704-719.

Kessler, S. S., Spearing, S. M., Attala, M. J., Cesnik, C. E. S. and Soutis, C. (2002), "Damage Detection in Composite Materials Using Frequency Response Methods", Composites, Part B: Engineering, Vol. 33, pp. 87-95.

Liang, C., Sun, F. P. and Rogers, C. A. (1994), "Coupled Electro-Mechanical Analysis of Adaptive Material Systems- Determination of the Actuator Power Consumption and System Energy Transfer", Journal of Intelligent Material Systems and Structures, Vol. 5, pp. 12-20.

Pandey, A. K., Biswas, M. and Samman, M. M. (1991), "Damage Detection from Changes in Curvature Mode Shapes", Journal of Sound and Vibration, Vol. 145, No. 2, pp. 321-332.

Pandey, A. K. and Biswas, M. (1994), "Damage Detection in Structures Using Changes in Flexibility", Journal of Sound and Vibration, Vol. 169, No. 1, pp. 3-17.

Park, G., Kabeya, K., Cudney, H. H. and Inman, D. J. (1999), "Impedance-Based Structural Health Monitoring for Temperature Varying Applications", JSME International Journal, Vol. 42, No. 2, pp. 249-258.

PI Ceramic (2019), http://www.piceramic.com

OTHER REFERENCES

Peairs, D. M., Park, G. and Inman, D. J. (2003), "Improving Accessibility of the Impedance-Based Structural Health Monitoring Method", Journal of Intelligent Material Systems and Structures, Vol. 15, No. 2, pp. 129-139.

Saffi, M. and Sayyah, T. (2001), "Health Monitoring of Concrete Structures Strengthened with Advanced Composite Materials Using Piezoelectric Transducers", Composites Part B: Engineering, Vol. 32, No. 4, pp. 333-342.

Sirohi, J. and Chopra, I. (2000a), "Fundamental Behaviour of Piezoceramic Sheet Actuators", Journal of Intelligent Material Systems and Structures, Vol. 11, No. 1, pp. 47-61.

Sirohi, J. and Chopra, I. (2000b), "Fundamental Understanding of Piezoelectric Strain Sensors", Journal of Intelligent Material Systems and Structures, Vol. 11, No. 4, pp. 246-257.

Soh, C. K., Tseng, K. K. H., Bhalla, S. and Gupta, A. (2000), "Performance of Smart Piezoceramic Patches in Health Monitoring of a RC Bridge", Smart Materials and Structures, Vol. 9, No. 4, pp. 533-542.

Stubbs, N. and Kim, J. T. (1994), "Field Verification of a Nondestructive Damage Localization and Severity Estimation Algorithm", Texas A & M University Report prepared for New Mexico State University. (refer Farrar et al, 1998)

Winston, H. A., Sun, F. and Annigeri, B. S. (2001), "Structural Health Monitoring with Piezoelectric Active Sensors", Journal of Engineering for Gas Turbines and Power, ASME, Vol. 123, No. 2, pp. 353-358.

Zhang, Z. and Aktan, A. E. (1995), "The Damage Indices for Constructed Facilities", Proceedings of 13th International Modal Analysis Conference, 13-16 Feb, Nashville, Vol. 2, pp 1520-1529. (refer Farrar et al, 1998)

Zimmerman, D. C. and Kaouk, M. (1994), "Structural Damage Detection Using a Minimum Rank Update Theory", Journal of Vibration and Accoustics, Vol. 116, pp. 222-231.