The Hong Kong Polytechnic University

Subject Description Form

Subject Code	CSE6011
Subject Title	Structural Performance Monitoring
Credit Value	3
Level	6
Pre-requisite / Co-requisite/ Exclusion	Structural dynamics
Objectives	(1) To expose students to the new and innovative health monitoring technology for sustainable infrastructure; (2) To develop a understanding of the basic theory and practical use of health monitoring system and technology; and (3) To enable students to design and implement health monitoring technology for sustainable infrastructure.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) design appropriate and cost-effective health monitoring systems for sustainable infrastructure; b) process and interpret various types of data from a structural health monitoring system; c) evaluate structural performance based on analyzed data and other information; and d) provide the findings for the client, designer, contractor, or other relevant sectors on the safety and sustainability of the infrastructure through oral presentations and written reports.
Subject Synopsis/ Indicative Syllabus	1. Introduction (1.5 weeks) Infrastructure, built environment, safety, sustainability, recent developments in health monitoring technology 2. Health monitoring system (1.5 weeks) Sensors and sensing technology, data acquisition and transmission system, data processing and control, data management system, design of health monitoring system 3. Finite element modeling (1 week) Beam model, solid model, hybrid model, model updating 4. Structural dynamics and testing (2 weeks) Basic of structural dynamics, modal testing and modal analysis 5. Monitoring of structural loadings and effects (3 weeks) Traffic load, temperature load, wind load, other loads

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<tr><td></td><td>6. Structural damage detection (1 week)
Vibration based methods, non-destructive testing methods

7. Project works (3 weeks)
Analysis of data from a health monitoring system or laboratory testing on a test-bed, written report, oral presentation</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>Fundamental knowledge related to health monitoring of infrastructure for safety and sustainability will be presented in lectures. Real applications to some landmark infrastructure will be demonstrated in details. Assignments will help students consolidate their understanding and implementation of commonly used data processing techniques. Laboratory testing on a test-bed and real practice on some structural health monitoring systems will help students to understand the basic methods used in structural health monitoring and the challenges for the real infrastructure. Final oral presentation will train the students on presentation and communication skills.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. Assignments</td><td>30</td><td></td><td>√</td><td>√</td><td></td><td></td><td></td></tr>
<tr><td>2. Project report</td><td>40</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td><td></td></tr>
<tr><td>3. Project presentation</td><td>30</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td><td></td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="6"></td></tr>
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<tr><td>Student Study Effort Required</td><td>
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<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures/Tutorial</td><td>30 Hrs.</td></tr>
<tr><td>▪ Project/Laboratory/Presentation</td><td>9 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading and studying</td><td>48 Hrs.</td></tr>
<tr><td>▪ Completion of reports</td><td>30 Hrs.</td></tr>
<tr><td>▪ Total student study effort</td><td>117 Hrs.</td></tr>
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<tr><td>Reading List and References</td><td>Books
1) Xu, Y.L. and Xia, Y., (2011), Structural Health Monitoring of Long Span Suspension Bridges, Spon Press.
2) Boller, C., Chang, F.K. and Fujino, Y., 2009, Encyclopedia of Structural Health Monitoring, (Chichester: John Wiley & Sons).
3) Clough, R.W. and Penzien, J., 1993, Dynamics of Structure, 2nd edition, (New York: McGraw-Hill).</td></tr>
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4) FHA, 2006, *Bridge Inspector's Reference Manual*, (Federal Highway Administration).
5) Friswell, M.I. and Mottershead, J.E., 1995, *Finite Element Model Updating in Structural Dynamics*, (Boston: Kluwer Academic Publishers).
6) Frýba, L. 1996, *Dynamics of Railway Bridges*, (Thomas Telford House).
7) Gimsing, N.J., 1997, *Cable Supported Bridges: Concept and Design*, 2nd ed., (New York: Chichester).
8) Hellier, C.J., 2001, *Handbook of Nondestructive Evaluation*, (USA: McGraw-Hill).
9) Karbhari, V.M. and Ansari, F., 2009, *Structural Health Monitoring of Civil Infrastructure Systems*, (Cambridge: Woodhead Publishing Limited).
10) Maia, N.M.M., Silva, J.M.M., He, J., Lieven, N.A.J., Lin, R.M., Skingle, G.W., To, W., and Urgueira, A.P.V., 1997, *Theoretical and Experimental Modal Analysis*, (England: Research Studies Press Ltd).
11) Mufti, A., 2001, *Guidelines for Structural Health Monitoring*, (Winnipeg: Intelligent Sensing for Innovative Structures).
12) Rohsenow, W.M., 1988, *Handbook of Heat Transfer Applications*, (New York: McGraw-Hill).
13) Zienkiewicz, O.C. and Taylor, R.L., 1994, *The Finite Element Method, Vol. 1: Basic Formulation and Linear Problems*, 4th ed., England, (Berkshire: McGraw-Hill).

Papers and reports

14) Blejwas, T.E., Feng, C.C., and Ayre, R.S., 1979, Dynamic interaction of moving vehicles and structures. *Journal of Sound and Vibration*, 67, pp.513-521.
15) Brownjohn, J.M.W., 2007, Structural health monitoring of civil infrastructure. *Philosophical Transactions of the Royal Society A*, 365 (1851), pp. 589-622.
16) Consolazio, G.R., Cook, R.A., McVay, M.C., Cowan, D.R. and Biggs, A.E., 2006, *Barge Impact Testing of the St. George Island Causeway Bridge, Phase III: Physical Testing and Data Interpretation*, Structural Research Report No. BC-354-RPWO-76, University of Florida.
17) Deng, L. and Cai, C.S., 2010, Bridge sour: prediction, modeling, monitoring, and countermeasures - review. *Practice Periodical on Structural Design and Construction, ASCE*, 15(2), pp. 125-134.
18) Doebling, S.W, Farrar, C R, Prime, M.B and Shevitz, D.W, 1996, *Damage Identification and Health Monitoring of Structural and Mechanical Systems from Changes in their Vibration Characteristics: A Literature Review*, Los Alamos National Laboratory Report LA-13070-MS.
19) Kareem, A., 2008, Numerical simulation of wind effects: A probabilistic perspective. *Journal of Wind Engineering and Industrial Aerodynamics*, 96(10-11), pp.1472-1497.
20) Ko J.M. and Ni Y.Q., 2005, Technology developments in structural health monitoring of large-scale bridges. *Engineering Structures, ASCE*, 27, pp. 1715-1725.
21) Ni, Y. Q., Xia, Y., Liao, W. Y. and Ko, J. M., (2009), "Technology Innovation in Developing the Structural Health Monitoring System for Guangzhou New TV Tower", *Structural Control and Health Monitoring*, 16 (1), 73-98.
22) Song, H.W. and Saraswathy, V., 2007, Corrosion monitoring of reinforced concrete structures - a review. *International Journal of Electrochemical Science*, 2, pp. 1-28.
23) Xu, Y.L., 2008, Making good use of structural health monitoring systems: Hong Kong's Experience. In *Proceedings of The Second International Forum on Advances in Structural Engineering, Structural Disaster Prevention, Monitoring and Control*, Dalian, China, pp. 159-198.