Syllabus (Autumn, 2018)

<table>
<tr><td>Course ID</td><td>M2794.009600</td><td>Lecture No.</td><td>002</td><td>Course Name</td><td>Prognostics and Health Management</td><td>Credits</td><td>3</td></tr>
<tr><td rowspan="3">Instructor</td><td colspan="3">Professor Youn Byeng Dong</td><td colspan="4">Website: shrm.snu.ac.kr</td></tr>
<tr><td colspan="3">E-mail : bdyoun@snu.ac.kr</td><td colspan="4">Telephone: 880-1919</td></tr>
<tr><td colspan="7">Office hour / office : 301-1514</td></tr>
<tr><td>TA</td><td colspan="7">Sunuwe Kim/ Yunhan Kim (kimsunny@snu.ac.kr, gav0304@snu.ac.kr)
(T: 1664) (Office: 301-215)</td></tr>
<tr><td>1. Objective</td><td colspan="7">This course provides the concepts and methods of prognostics and health management (PHM) with various kinds of case studies. The course covers four important issues encountered in practical engineering fields: data acquisition, health reasoning for diagnosis, health classification for diagnosis, health prognosis. Data acquisition includes various sensor types and their network design. Health reasoning includes signal pre-processing and processing for vibrational / non-vibrational case. Health classification covers statistical methods and machine learning methods. Health prognosis includes physics-based approach and data-driven approach. Some management techniques are briefly introduced for the purpose of asset management. After studying the theoretical contents, each case studies will be presented how PHM techniques are used in engineering fields.</td></tr>
<tr><td>2. Textbook & References</td><td colspan="7">− Youn, B.D. and Hu, C., Engineering Desing under Uncertatinty and Health Prognostics, Springer, 2018.
− Kim, N., et al., Prognostics and Health Management of Engineering Systems, Springer, 2017.
− Gouriveau, R., et al., From Prognostics and Health Systems Management to Predictive Maintenance 1: Monitoring and Prognostics, Wiley, 2016.
− Vachtsevanos, G., et al., Intelligent Fault Diagnosis and Prognosis for Engineering Systems, First edition, Wiley, 2006.
− PPT Lecture Note</td></tr>
<tr><td rowspan="2">3. Evaluation method</td><td>Homework</td><td colspan="2">Exam I</td><td>Project 1</td><td>Project 2</td><td>Project 3</td><td>Total</td></tr>
<tr><td>20%</td><td colspan="2">20%</td><td>20%</td><td>20%</td><td>20%</td><td>100%</td></tr>
<tr><td>4. Consideration</td><td colspan="7">− Prerequisites : Engineering Statistics, Design Optimization
− One mid-tem exam
− Three term projects
− Weekly assignments are included in the lecture note.</td></tr>
<tr><td>5. Rules</td><td colspan="7">− Homework assignments should be sumitted by the due date “in class”.
− For fairness on grading assignments, late submission is not allowed.
− All students are presumed upon enrollment to have an understanding of the Honor System.
− Academic dishonesty by a student will be treated in accordance with the SNU procedures. A score of “0” can be assigned for the corresponding test/assignment and/or a course grade of ‘F’ can be assigned.</td></tr>
<tr><td>6. Final Project</td><td colspan="7">− The projects will be an individual project. This requires a submission of a report (A4 10-page long, 12pt.) including a pseudo-code.
− Project 1 : Physics-based feature engineering (week 4-7)
− Project 2 : Deep learning based feature engineering (week 8-11)
− Project 3 : Health diagnostics and prognostics (week 12-15)</td></tr>
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Wk	Chapter	Contents
1	Chapter 1	Introduction: Prognostics & Health Management – Failure mode, effects, and critical analysis (FMECA), ALT, NDE – Data acquisition, health reasoning, classification, prognosis
2	Chapter 2	Statistical Analysis – Basic probability theory – Bayesian statistics
3	Chapter 3	Data Acquisition for PHM – FMECA, ALT, NDE, Design of Experiments (DOE) – Sensors for vibration data / non-vibration data – Sensor network design (Sensor type & number, DAQ spec., etc.)
4	Chapter 4	Health Reasoning for Diagnosis (Vibration based) – Time- & frequency- analysis (correlation analysis, DFT/CFT/FFT, STFT, wavelet) – Signal pre-processing techniques (resampling, filtering, TSA) – Signal processing techniques (spectral kurtosis, cepstrum)
5	Chapter 4	Health Reasoning for Diagnosis (Non-vibration based) – Signal processing techniques (empirical mode decomposition, envelope) – Non vibration-based (correlation analysis, standardization)
6	Chapter 5	Health Classification for Diagnosis – Error analysis (type-I,II error, recall, precision) – Statistical approaches (T-test) – Rule-based approaches (decision tree)
7	Chapter 5	Health Classification for Diagnosis – AI based diagnosis (non neural network) (FDA, SVM) – AI based diagnosis (neural network)
8	Chapter 5	Health Classification for Diagnosis – Introduction to deep learning (Supervised / unsupervised / reinforcement learning) (DBN, CNN, RNN, AE)
9	Chapter 6	Health Prognosis – Physics-based approach (nonlinear least squares, bayesian method, particle filer) – Data-driven approach (Guassian process regression, neural network, ensemble, co-training)
10	Exam Week	Exam & Project Description
11	Chapter 7	Management – Concept of asset management (corrective, preventive, predictive) – Maintenance scheduling strategies, resilience design, cost analysis
12	Chapter 8	Case Study for Vibration – Gear, rotor, motor
13	Chapter 8	Case Study for Vibration – Gear, rotor, motor
14	Chapter 8	Case Study for Non-vibration – Electric power system, battery
15	Chapter 8	Case Study for others – LDI, OLED, Fridgers, Motors

* The detail schedule is subject to further possible change.