SEEM4059: PROCESS MONITORING AND INSPECTION TECHNIQUES

Effective Term
Summer Term 2023

Part I Course Overview

Course Title
Process Monitoring and Inspection Techniques

Subject Code
SEEM - Systems Engineering and Engineering Management
Course Number
4059

Academic Unit
Systems Engineering (SYE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
MA1201 Calculus and Basic Linear Algebra II or MA2172 Applied Statistics for Sciences and Engineering or Equivalent

Precursors
Nil

Equivalent Courses
MBE4059/JC4059 Process Monitoring and Inspection Techniques

Exclusive Courses
Nil

Part II Course Details

Abstract

The aim of this course is to introduce effective methodology for monitoring prime manufacturing process and equipment so that their quality and maintainability can be guaranteed. The methodology is derived from advanced non-destructive evaluation methods with their related measurement methods and test tools. After completing the course, the students are expected to be capable of selecting suitable method(s) for measuring the health and analyzing the quality of a prime type/piece of process/equipment commonly used in industry. The students should also be able to design an effective and practical measurement and test platform for performing the required quantitative analysis on the process/equipment. The content of this course is especially designed to partially comply with the requirements of Certified Quality Engineer.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the maintainability of process/ equipment used in some prime manufacturing and the importance of quantitative measurement applied to such process/ equipment.	17	x		
2	Determine the scope of application, cost, benefits and constraints of popular non-destructive evaluation methods, their required tools and quantitative methods for assessing the quality and maintainability of the process/ equipment.	17	x		
3	Analyze the data/signals collected from the process/equipment so that the current health and availability of that process/equipment can be realized.	33		x	
4	Design effective quantitative measurement and monitoring methods for the process/equipment to minimize the occurrence of anomalous operating condition and the rate of degradation from the quality standards.	33		x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture and In-class discussion & performance(Large class)	There will be 24 hours for lecturing key issues related to advanced process/equipment for health monitoring and quality inspection. Some of the key syllabuses are listed in Part III. The amount of lecturing hours will be partitioned according to the CILOs as aforementioned. Real and practical industrial cases will be used to explain the theories introduced during the lecture hours. Live demonstration will also be given to illustrate the functions and effectiveness of each measurement method and tools that is applying to a selected process/equipment. Besides the regular lecture, there are in-class discussion and feedback, which are monitored to assess the individual student performance. Questions, which are related to industrial and real cases, will be given to students during class time. The students should study these case studies and gather related information from different sources, such as newspapers, Internet etc. The students are expected to provide their own opinions and comments of these case studies in the class. Then during the lectures, a number of questions will be raised and each student is encouraged to provide his/her views and feedbacks. The responses given by each students will be assessed and marked.	1, 2, 3, 4	2 hours/week

2	Laboratory (Small class)	A total of 4 sessions and the fifth session is for laboratory (lab) make-up. Each session has 3 hours for performing the required laboratory works. The main purpose is to allow the students to have hands-on experience on learned knowledge. Some of the planned laboratories could be but not limited as: the use of the Smart Asset Maintenance System (SAMS) for performing quantitative measurement in quality on selected manufacturing machines,familiarization of thermography and the use of infrared camera to monitor selected electronic circuitry production line in the compliance of some prime quality standards,familiarization of vision inspection and the use of digital image processing to monitor the operation and measure the performance of selected manufacturing process,the use of laser techniques in quality inspection for manufacturing process/ equipment, andthe use of virtual instrument tools in developing instrumentation platform for performing monitoring and quality inspection.	1, 2, 3, 4	15 hours/semester

3	Presentation(Large class)	Competitive Presentations: Students will work in groups on the design of effective quality monitoring strategies for a specific type of process/ equipment commonly used in industry. Their efforts and outcomes will be reported in the term paper as well as in a competitive presentation which will be held in the last week of the lecture. At the end of each group presentation, the other groups of student are compulsory to criticize the presented group by asking questions on the presentation. The instructor(s) will also make comment based on the presentation. Through the responses made by the presented group and the content of the presentation, ranks will be given to each group. Each group will have a rank and such rank will not be repetitive. The instructor(s) will give mark to each group based on her assigned rank. Each group will have a unique rank and mark, and there must be a highly ranked group will receive high mark, whilst, the group that ranked the lowest will receive the lowest mark. Hence, the presentations are competitive.	3, 4	2 hours/ semester
4	Consultation Hours	Consultation hours will be used to facilitate discussions of various issues related to the content of lectures, laboratory work and reports and term project.	1, 2, 3, 4	2 hour/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Term projects	1, 2, 3, 4	50	
2	Assignments/Lab Reports/ In-class discussion and performance	1, 2, 3, 4	40	
3	Competitive Presentations	3, 4	10	

Continuous Assessment (%)

100

Examination (%)

0

Assessment Rubrics (AR)

Assessment Task

Term project

Criterion

The term projects and their reports will contribute 50% of the final assessment. Each group of students must submit the reports for all term projects. To facilitate individual assessment, each student in a particular group must also submit his own detailed section of contribution (called ‘individual section’). In the individual section, each student must define clearly his role, the amount of work done, and the portion of his own contribution (in percentage) in completing the term projects. The student should also include his own discussion and conclusion in each report to verify his degree of understanding the term projects. The final mark given to each student may be varied due to the student’s actual contribution and achieved efforts toward the term projects. Moreover, there are in-class discussion and feedback and monitored by individual performance (12%). Different marks will be given to those student who have been actively involved in the discussion and provided sound feedbacks accordingly.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Assignments/ Lab Reports/In-class discussion and performance

Criterion

A total of 4 assignments will be given to students. Each assignment has a number of questions that are related to the course content and the above laboratory work. The students are expected to spend at least 4 hours for completing each assignment.

The main purpose is to check the students whether they have earned the expected learning outcomes and possessed the analytical skill to solve the problems given in each assignment. Each assignment will be given after completing each laboratory work. The 4 assignments will contribute equally to the total mark of 28% with 7% per assignment. Students must attend all 4 laboratory sessions. After completing each laboratory session, the students must submit an assignment that provide answers to the questions given in the lab sheet. Each assignment will be have a time of three weeks to complete. That is, every 3 weeks, there will be an assignment given to students.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Competitive Presentation

Criterion
20% of the coursework will be given for the presentations of the term-projects. Each student in a group must involve in the presentation as one of presenter(s) of their group term project. Ranking of the performance in presentation will be given based on the quality and clarity of the presentation and the presented contents. Questions and comments, either from the course examiner or the students, are encouraged to be given after each presentation.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus
Introduction to Prime Manufacturing Process and Equipment
Introduction to Maintainability and Availability
Brief Introduction to Safety of Machinery

Brief Introduction to Non-Destructive Evaluation Methods
Quantitative Measurement Methods and Tools used in Condition Monitoring and Quality Inspection
Basic Vibration-based Manufacturing Process/Equipment Monitoring
Fundamental Vision-based Quality Inspection
The Use of Thermography, Laser and other Advanced Technologies in Manufacturing Process/Equipment Monitoring
Design and Planning of Effective Measurement and Test Platform for Quality Monitoring of Manufacturing Process/Equipment
Industrial Case Study and Demonstration

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Tse P. et al, Smart Asset Maintenance System (SAMS) - User Manual, Smart Engineering Asset Management Laboratory (SEAM®).
2	Tlusty G., Manufacturing Process and Equipment, Prentice Hall, (ISBN 0-201498650).
3	Bently D., Hatch C. and Grissom B, Fundamentals of Rotating Machinery Diagnostics, Bently Pressurized Bearing Company, (ISBN 0-9714081-0-6).
4	Russ John, Introduction to Image Processing and Analysis, CRC Press, (ISBN 9780849370731).
5	Dodson B., The Weibill Analysis Handbook, 2nd edit., ASQ Quality Press, (TS 173 .D63 2006). Software included.