MEC7107: Measurement Techniques in Energy Engineering

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
30	15	15	45	100	60	40	3

Course Description:

This course focuses on developments of measurements in thermal systems. Such systems are complex, expensive and polluting. It is therefore important to be able to determine their performance and their efficiency, since thermal systems enter our daily life directly through generation of electricity, Heating, Ventilation and Air-Conditioning and Transport, and indirectly through chemical processes such as fabricating materials for daily use. Without measurements, scientific models and theories cannot be rigorously tested or challenged hence implying that they are indispensible.

Course Objective:

Energy systems have had numerous developments over the years. Large computers allow increasing number of areas to be numerically simulated. For this case numerical models and simulations need to be verified and experiments are necessary. Since many systems and components involve physics which is not known in detail, this course is intended to study experimental investigations and empirical models while focusing on the main measurement lines in thermal systems such as Research and Development, Acceptance tests and monitoring and diagnostics.

At the end of this course, the student should be able to:

- Describe the role of measurement in thermal systems' studies
- Describe the various techniques used and compare their performance measures
- Specify in detail the various methods available for measuring key thermal system characteristics
- Explain and carry out the methods used for analysis of experimental data
- Plan, execute and satisfactorily report experimental measurements of thermal systems characteristics

Course Learning Outcome:

The goal of the course is that the students should appreciate the role of measurements in testing or challenging scientific models and theories.

Course Outline:

General introduction to measurement techniques in Thermal Fluid systems: **(4 Hours)**

- The nature of measurements
- Types of Measurements,

- Measurement as a Process,
- Measurement as a relation, the elements of a Measuring process,
- Sources of Variability in Measurement,
- Scales of Measurement

Introduce different techniques: **(3Hours)**

- Risk analysis, Introduction to risk analysis,
- key objectives risk management process

Evaluate available methods for a specific application: **(8 Hours)**

- Pressure measurements, pressure transducers,
- High accuracy multi-channel system, averaging,
- Dynamic characteristics, static and dynamic calibration,
- Temperature measurements,
- Methods for Temperature Measurement, Calibration,
- Thermal conductivity, Viscosity, Calorimetry,
- Surface tension, Heat flux, Density of fluids. Flow measurements.

Uncertainty estimation of measured data: **(8 Hours)**

- Data Reduction and Associated Experimental Uncertainty,
- Error analysis, uncertainty of functions,
- Uncertainty of measurements, uncertainty of correlated input,
- Basic data reduction, Type A and B uncertainty,
- Confidence intervals, least square method regression analysis,
- General considerations in data analysis.

Planning experiments: **(4 Hours)**

- Preliminary, intermediate and final stages of an experimental program,
- experimental log book, experimental reports,
- report check list, similarity and analogy, case studies

Reporting experiments **(3 Hours)**

Hands-on experiments **(15 hours)**

Delivery Methods

Include formal lectures (including those from Visiting Lecturers), case studies, tutorial exercises, practical demonstrations, directed learning and individual work

Assessment

The method of assessment is by written examination and evaluation from case studies, Home Assignments and Laboratory Exercises as course work. The Course work takes (40%) and Final Exam takes (60%).

References

1. Holman J.P ,(2001) Experimental Methods for Engineers 7ed., McGraw-Hill, ISBN 0-07-118165-2

2. Taylor B.N., Kuyatt C.E.,(1994), Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, NIST Technical Note 1297, 1994ed.
3. KirkupL., Frenkel B. (2006) An introduction to Uncertainty in Measurements Using the GUM, ISBN 0-521-60579-2
4. Taylor J.R.(2001) An Introduction to Error Analysis. The study of uncertainties in physical measurements, 2ed, ISBN 0-935702-75-X
5. Coleman H.W., Steele W.G.(1998), Experimentation and Uncertainty Analysis for Engineers, 2ed, ISBN 0-471-12146-0
6. Bevington P.R., Robinson D.K.(2004), Data Reduction and Error Analysis for the physical science, 3ed, ISBN 0-07-247227-8
7. Rabinovich S.G.(2003), Measurement Errors and Uncertainties –Theory and practice, 3ed, ISBN 0-387-25358-0–Lee T.-W., Thermal and Flow Measurements, ISBN 978-0-8493-7970-3
8. Webster J.G., et al.,(1995) Mechanical Variables Measurement –Solid, Fluid, and Thermal, CRC Press, ISBN 0-8493-0047-9 ISO, Guide to the expression of uncertainty in measurement (GUM), corrected and reprinted, ISBN 92-67-10188-9