Cairo University
Faculty of Engineering
Mech. Power Department

ACC Virtual Labs
Automatic Control Circuits & Virtual Labs for Mechanical Power Systems
معمل التحكم الأوتوماتيكى و المعامل الإفتراضية لأنظمة القوى الميكانيكية

دبلوم تطبيقات التحكم الأوتوماتيكى فى نظم القوى الميكانيكية

MEP 560 Instrumentation for Measurements, Tests & Control of Mech. Power Systems

Dr. Mohsen Soliman, ACC Manager
Mechanical Power Engineering Department

إسم المقرر - مكق 560 أجهزة القياس والإختبارات والتحكم فى نظم القوى الميكانيكية:

المحتوى والأهداف: تحديد التعريفات والمكونات الاساسيه لمنظومه القياس، مفهوم المعايرة ورد الفعل الديناميكي، تحديدأهمية الدقة ومقدار الخطأ ومعامل عدم التأكد في القياسات العملية، وصف طرق التحليل الإحصائي والتمثيل البياني لنتائج القياسات، دراسة التطبيقات العملية لوسائل القياس من دوائر كهربية وأجهزة تقنين الإشارات، وصف إستخدام الحاسب الآلي في أخذ البيانات ومعالجتها أثناء وبعد القياسات. دراسة وتحليل ووصف طرق وأجهزة قياس كل من الضغط ودرجه الحرارة ومعدل السريان وسرعه الموائع والقوة والعزم وسرعة الدوران، تعريف مبادىء التحكم، شرح نظم التحكم فى الضغط ودرجه الحرارة ومعدل سريان الموائع.

Contents: **Basic definitions – Concept of Calibration, static and dynamic response – Importance of accuracy, error-propagation and uncertainty analysis in experimental measurements – Methods of statistical analysis and graphical presentation of experimental results – Practical applications of measurement devices, electrical instruments, and signal conditioning devices – Using of Personal Computers in data accusation, processing and analysis during and after experimental measurements. Measurements of pressure, temperature, flow rate, fluid velocity, force. Control of Pressure, temperature, and flow rate.**

References

EXPERIMENTAL METHODS FOR ENGINEERS
Third Edition

J. P. Holman
Professor of Mechanical Engineering
Southern Methodist University

W. J. Gajda, Jr.
Professor of Electrical Engineering
University of Notre Dame

McGraw-Hill Book Company
New York St. Louis San Francisco Auckland
Bogotá Düsseldorf Johannesburg London Madrid Mexico
Montreal New Delhi Panama Paris
São Paulo Singapore Sydney

Fluid Flow Measurement
A Practical Guide to Accurate Flow Measurement
Second Edition
E.L. Upp Paul J. LaNasa

Gulf Professional Publishing
an imprint of Butterworth-Heinemann
Boston Oxford Auckland Johannesburg Melbourne New Delhi

Course Objectives & Contents

To answer Three main questions:

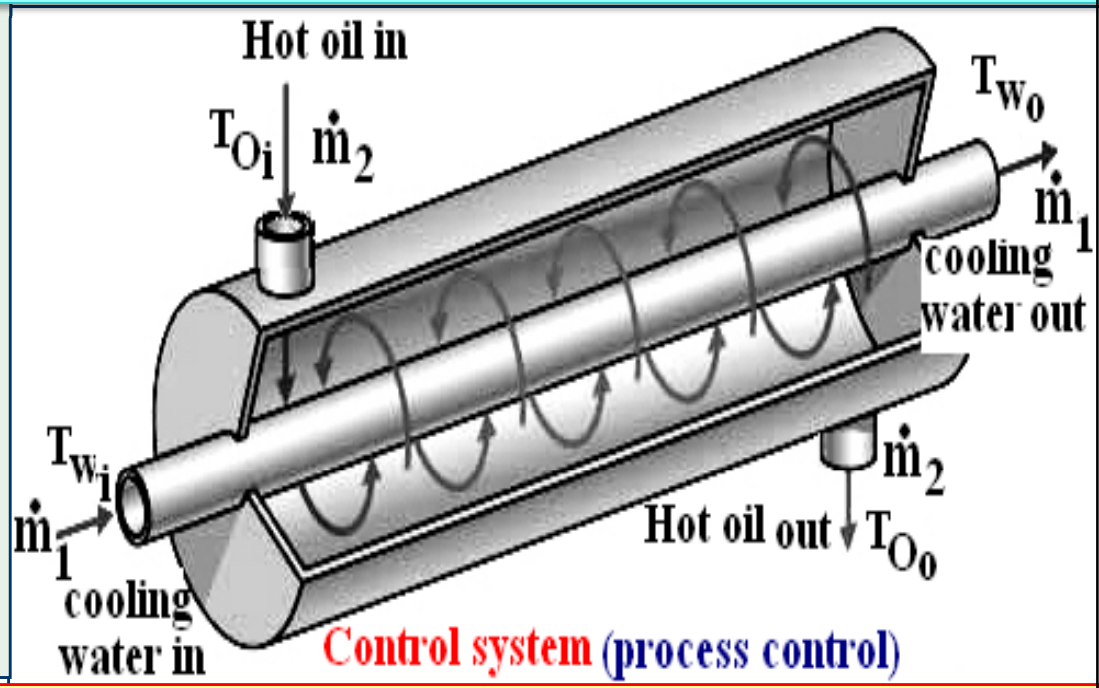
1-What do we mean by Measurements and Instrumentations?

2-Why do we need Measurements/Tests (what is relation with Automatic Control systems)?

3-How can we do accurate and meaning-full Measurements, Tests, and Calibrations?

Measurements & Instrumentations are Part of Process Control (measure + compare +adjust):

Example: if we have process with physical parameters/variables to be controlled (e.g., $T_{oil\text{-}out}$ to be kept ≤ set point). To do this we have many steps: 1st, these physical variables have to be measured by sensors. Output signals (electric) are sent to controller (PLC/ PID) unit to do control actions based on preset data+measured values. Controller may do control actions by controlling flow rate of either water or oil by variable flow valves, or changing rpm of variable speed pump.



عمليةالقياس من العمليات الصعبةوالهامة والحيوية في كافةالتطبيقات االهندسيةوالبحثية (وأيضاً فالتطبيقات الغير علمية):

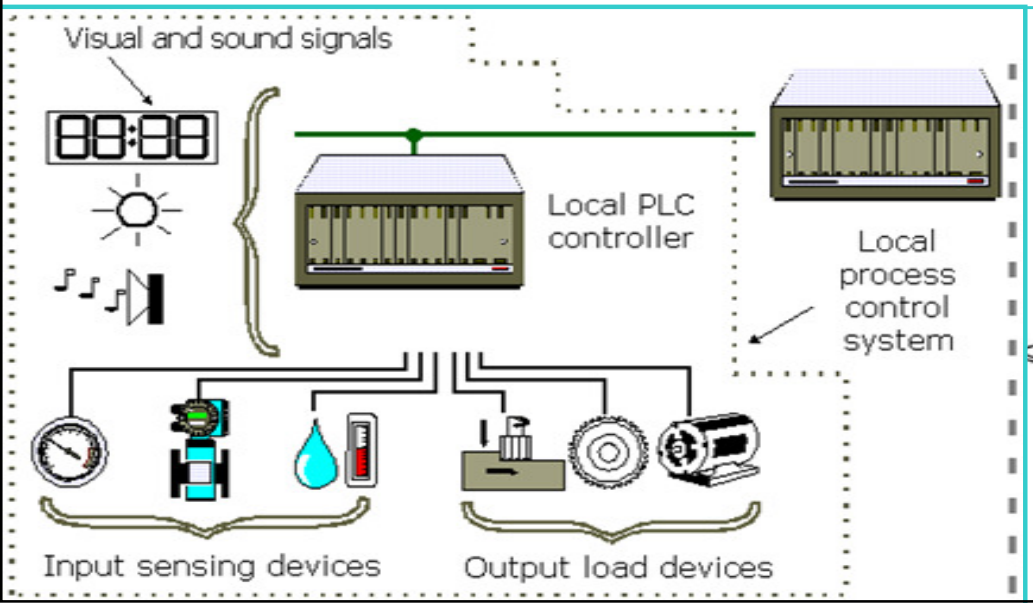
- مثال قياسات ميكانيكية: تعين مقدار كمى محدد لكميات طبيعية: F, T, P, M, ρ, μ, k، معدل التدفق ، الشغل المبذول ، السرعة.....
- مثال قياسات طبية: تعين مقدار كمى لكميات: ضغط الدم، فصيلة الدم، نسبة الهيموجلوبين، سرعة الترسيب، نسبة سكر الدم، نسبة الإعاقة.
- مثال قياسات زراعية: تعين مقدار كمى محدد لكميات :درجة ملوحة التربة ، متوسط انتاج المحاصيل ، نسبة تفتح اللوز ، نسبة الإنبات...
- مثال قياسات إدارية: تعين مقدار كمى لكميات:معدل الربح، نسبة الإشغال،حجم إنجاز المشروع، نسبة المخاطرة، مستوى كفاءة العامل...
- مثال قياسات سياسية:تعين مقدار كمى لكميات:معدل البطالة ، نسبة التأييد الشعبي ، نسبة التصويت ، نسبة التضخم، نسبة المشاهدة....

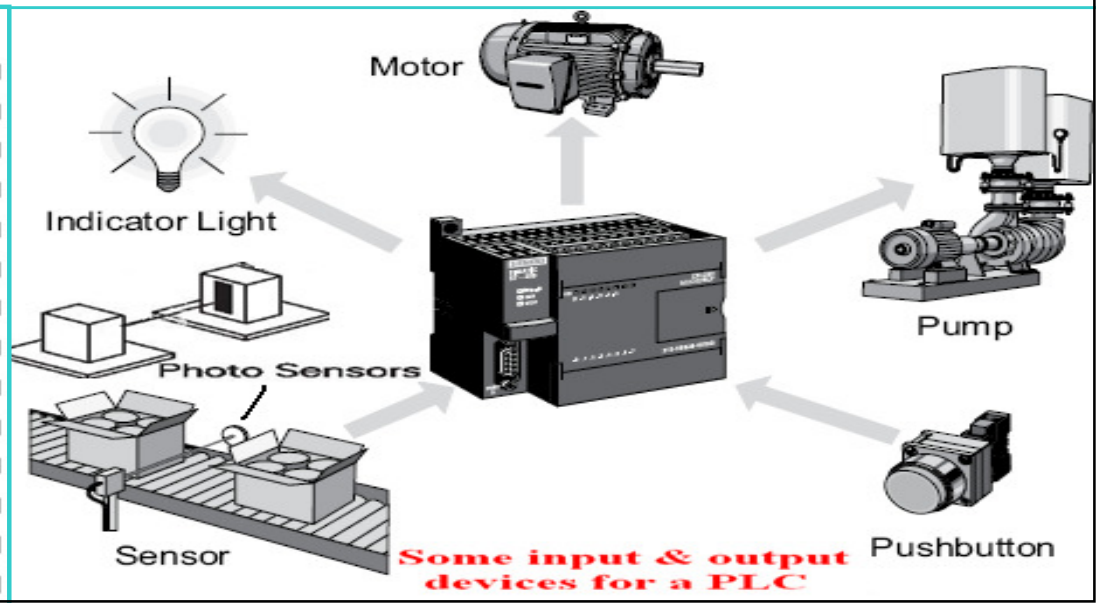
هدف المقرر:تعريف وتحديد ووصف أهم عناصر منظومةالقياس بصفةعامة (يشمل ذلك تخطيط التجارب، تحليل الأخطاء والنتائج المعملية، كتابةالتقاريرالفنية)، ويشمل ذلك دراسة بعض أجهزة القياسات الهندسية التي تهم مجالات القوى الميكانيكية بصفةعامةً وفى مجالات التحكم الأوتوماتيكى فى نظم وتطبيقات القوى الميكانيكية بصفة خاصة .

محتوى هذا المقرر-الجزء الأول الإجبارى(مكق 560-القياسات والإختبارات):التعريفات،المصطلحات،المكونات الاساسية لمنظومه القياس، مفهوم المعايرة ورد الفعل الديناميكي، أهمية الدقة ومقدار الخطأ ومعامل عدم التأكد في القياسات العملية، طرق التحليل الإحصائي والتمثيل البياني لنتائج القياسات، أمثلة لبعض التطبيقات العملية لوسائل القياس من دوائر كهربية وأجهزة تقنين الإشارات، إستخدام الحاسب الآلي في أخذ البيانات ومعالجتها أثناء وبعد القياسات. طرق وأجهزة قياس كل من الضغط ودرجه الحرارة ومعدل السريان وسرعه الموائع والقوة والعزم وسرعه الدوران.

الجزء الثانى(مقرر إختيارى: مكق 587 موضوعات مختارة فى نظم التحكم-تطبيقات أجهزة القياس فى PLC): مبادىء عملية التحكم،أهم أنواع وتطبيقات الأجهزة الكهربية الأساسية الموجودة فى نظم التحكم الأوتوماتيكى(خاصة مع PLCs)

Part 2 provides very valuable technical & essential information about basics of main electric components &most fundamental PLCs Input & Output devices, such as: Proximity Sensors, Photo-electric Sensors, Switches, Relays, Contactors, Timers, Counters, AC/DC Power supplies, Temperature Controllers, inverters, &others. Understanding of Part 2 is essential for the benefit of the newcomers to PLCs industry. Real-life examples are also incorporated in this course. This course is pre-requisite or must be completed before attempting to study thoroughly about the Basics of PLCs. Understanding of many of concepts covered in this course is required for understanding practical applications of PLCs and control systems.





Course Specifications & Basic Information

1. Title:	Instrumentations for Measurements, Tests& Control in Mechanical Power Systems			Code:MEP560
2.Credit hrs per week	Lectures= 3 hours per week	Tutorial= 0.0	Practical= 0.0	Total=3 Cr.Hrs

B- Professional Information

1. Course description: Overall Aims:

This is a mandatory course as one of the 6 mandatory core courses of the Diploma. It is designed to show the closeness and direct relation between measurement and control system. The course shows that system output measurement is a must for any closed-loop control system. The measurement system provides the essential feed-back signal which to be compared with the required set-point in order to produce the input of the system controller. Without doing output measurement, the system shall be an open loop control system. Accuracy &efficiency of control system shall greatly depend on the measurement system. Course overall aims is to introduce basic measurement definitions–Concept of Calibration, static and dynamic response – Importance of accuracy, error-propagation and uncertainty analysis in experimental data–Methods of statistical analysis and graphical presentation of experimental results – Practical applications of measurement devices, electrical instruments, and signal conditioning devices – Using of Personal Computers in data accusation, processing and analysis during and after experimental measurements. Measurements of pressure, temperature, flow rate, fluid velocity, force. Control of Pressure, temperature, and flow rate.

2. Intended Learning Outcomes of Course (ILOs):

a) Knowledge and Understanding:

Having successfully completed this course, the post-graduate student should have knowledge and understanding of:

-Basics of experimental measurement definitions such as: transducers, uncertainty, accuracy, random or biased errors, various types of hysteresis, impedance matching, ...etc.

-Importance of measurements and feed-back processes in closed-loop automatic control systems.

-Concepts and importance of instrument calibration, static response and dynamic response of a measurement system.

-Uncertainty analysis, Statistical calculations of experimental measurement results/outputs, and graphical data presentation.

-Various types of practical measurement transducers, types of signal conditioning devices, data acquisition hardware and software systems, and data output processing and displaying tools.

-Various equations for experimental error propagation and data uncertainty analysis.

-Structure, function, and theory of different types of transducers and sensors used for measurement of electric signals, pressure, temperature, flow rate, flow velocity, force, ...etc.

-b) Intellectual Skills:

Having successfully completed this course, the student should have the ability to do:

-Select & apply appropriate mathematical, and technical optimum methods to design, model and analyze measurement problems relevant to automatic control systems.

-Verify accuracy & validity of calibration different types of transducers and measurement devices.

-Search for scientific & technical information and adopt control self-learning capabilities.

- Analyze and compare the performance and time response of different types of transducers and measurement devices.

-Compare between practical measurement devices, transducers and several methods for signal conditioning, data acquisition, and different output displaying and processing systems.

-Solve numerical examples on uncertainty analysis & error propagation in measurement systems.

- Study, describe, & compare between different methods for measurement of pressure, temperature, flow rate, flow velocity, and force ...etc.

c) Professional and Practical Skills:

Having successfully completed this course, the student should have the ability to do:

-Identify several types of measurement problems which are essential for operation and control of mech. power systems and energy transfer processes.

-Perform professional design for different measurement & data acquisition/processing systems.

-Use, apply & calibrate different types of measurement & data acquisition/processing systems.

-Diagnose accuracy, uncertainty, and error propagation problems of measurement & signal conditioning devices.

-Assess performance & Compare the technical specifications of different types of measurement and data acquisition and processing systems.

-Suggest possible alternatives for various types of transducers and measurement devices.

d) General and Transferable Skills:

Having successfully completed this course, the student should have the ability to do:

-Perform engineering calculations, draw feed-back control circuits, block diagrams, graphical presentation of experimental data, and perform data-regression analysis.

-Transfer knowledge, Work in group, & Communicate in written & oral forms, in English.

- Use IT& evolutionary technological tools& PC applications (Excel, Mat lab, Virtual labs, .etc).

- Prepare & write reports, Manipulate & sort data, Think logically, and continuous self-E-learning.

- Identify practical problems, compare between different technologies for measurement systems.

-Organise & manage time & resources effectively; for short-term and longer-term commitments.