Cairo University
Faculty of Engineering
Mech. Power Department

ACC Virtual Labs
Automatic Control Circuits & Virtual Labs for Mechanical Power Systems

دبلوم تطبيقات التحكم الأوتوماتيكى فى نظم القوى الميكانيكية

MEP 571 Using Virtual Lab Applications for Industrial Air-Conditioning (HVAC) Plant

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What do we study? **ملاحظة:** هذا ليس مقررلتدريس تكييف الهواء للمبتدئين ولكن مقرر متقدم للتدريب على نظم التحكم الأوتوماتيكى

مكق 571 تطبيقات المعامل الإفتراضية فى التحكم فى أنظمة تكييف الهواء المركزية (المحتويات حسب اللائحة):

-دراسة/مراجعة/التعرف على وتحليل عناصرالعديدمن مكونات دورات تكييف الهواءوأجهزةومعدات نظم التحكم الآلى المستخدمةفى نظم تكييف الهواء

- دراسة حالة تطبيقية من خلال برنامج معامل إفتراضية تفاعلى للتحكم الأوتوماتيكى وتشغيل وإدارة كافة أجزاء محطة تكييف هواء مركزية لمبنى إدارى تعمل بنظام الهواء الكلى والخلط المسبق لنسب متنوعة من الهواء الراجع مع الهواء الخارجى لضمان تجديدالتهوية للمكان المكيف. وتتضمن المحطة أربعة طلمبات مركزية لتشغيل أربعة خلايا لوظائف التسخين والتبريد وزيادة الرطوبة وإعادة التسخين للهواء.

- يتضمن المقرر تحليل كافة نظم القياس والتحكم الأوتوماتيكى فى البرنامج لمعرفة وظائفها وتفاصيل عملها وماهية مخرجاتها.

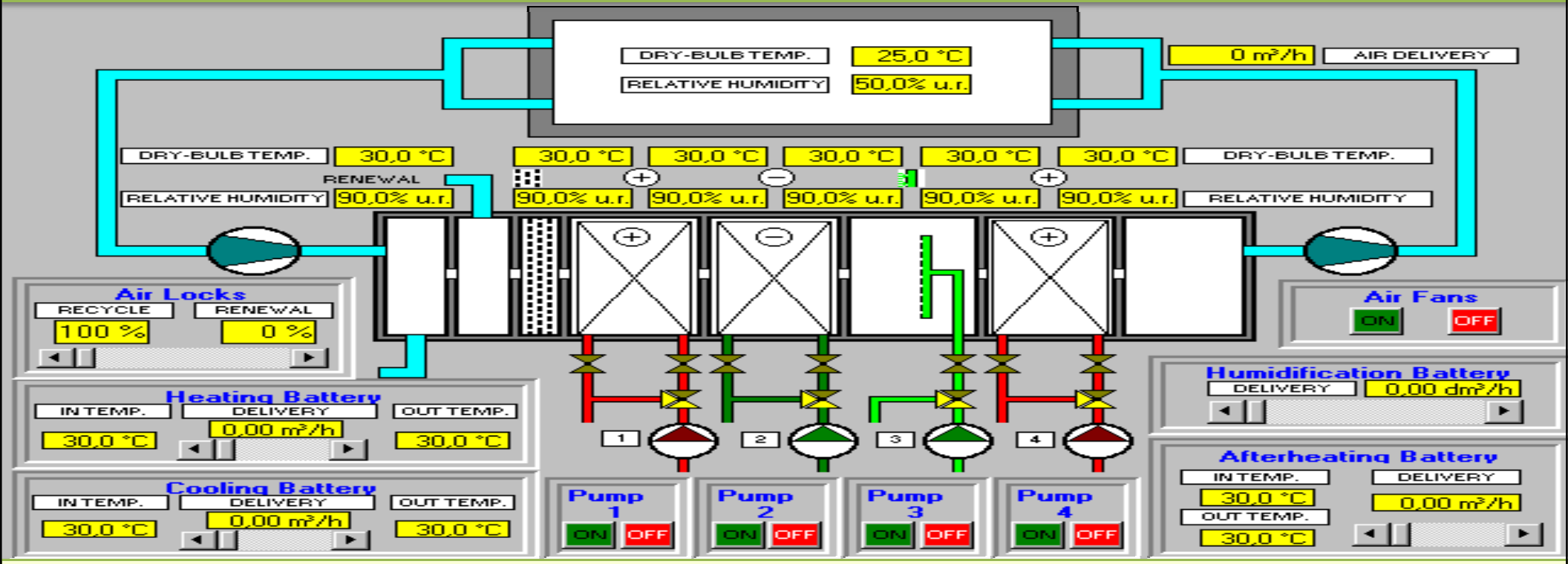
- تحليل كافة عمليات الديناميكا الحرارية وميكانيكا الموائع وإنتقال الحرارة المستخدمة فى جميع أجزاء المحطة (الموضحة فى البرنامج).

- التدريب على ممارسة ما يتم من تطبيق للقوانين المختلفة والحسابات المعقدة فى عمليات التحكم الفعلية لمحطات تكييف الهواء المركزية للوصول للنتائج المنتظرة من عملية التحكم. كما يهدف المقرركذلك إلى التأكد من مصداقية هذه البرامج وعمل معايرة علمية لمخرجاتها من خلال التحقق من القوانين والحسابات الداخلية التى تتم فى هذه البرامج وإجراء عمليات مقارنة بينها وبين الحسابات التقليدية الموازية للوصول لنفس المخرجات والنتائج العملية مثل رسم وتوقيع كافة ظروف التشغيل on-lineعلى خرائط السيكومترى لحالة الهواء عند كافة مراحل التكييف وكذلك عمل الإتزان الحرارى وتحديد القدرة وكفاءة المحطة عند ظروف التشغيل وكافة الاحمال المختلفة.

What do we have in the Industrial or Central Air-Conditioning Plant under investigation?

Course Contents: **This is an interactive computer-based training course that includes an investigation, a virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control & real thermo-fluid processes existing in an industrial plant used to air-condition a building to some pre-specified dry-bulb temperature and relative humidity. Air-locks are used to have different adjustable ratios of recycled air brought back to the building mixed with some renewal air. The plant includes 4 centrifugal pumps for the 4 battery cells for heating, cooling, humidification, and after-heating. Each pump has its on/off control board. Each battery cell has a control board that includes a pump flow rate-meter and both inlet and outlet cell temperature (except the humidification cell). The plant has an on/off air fans or ventilators control board and air locks control board. On-line, real psychometric diagram is plotted showing all performed processes. The diagram shows a point for Renewal air, point for Recycled air taken from inside the environment, a point for the mixture of Renewal and Recycled air, points for the air outlet from the various A/C plant batteries, and last point for the air going to the environment-building. The simulation includes many flow control valves and temperature read-out gauges. , many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic tools, error-report filling, help/trouble-shooting and Thermal Balance Calculations and Plotting tools.**

THW-4 Simulation of an Industrial Air-Conditioning Plant هذا رسم تخطيطى لمحطة ومعدات تكييف الهواء المركزية التى ندرسها



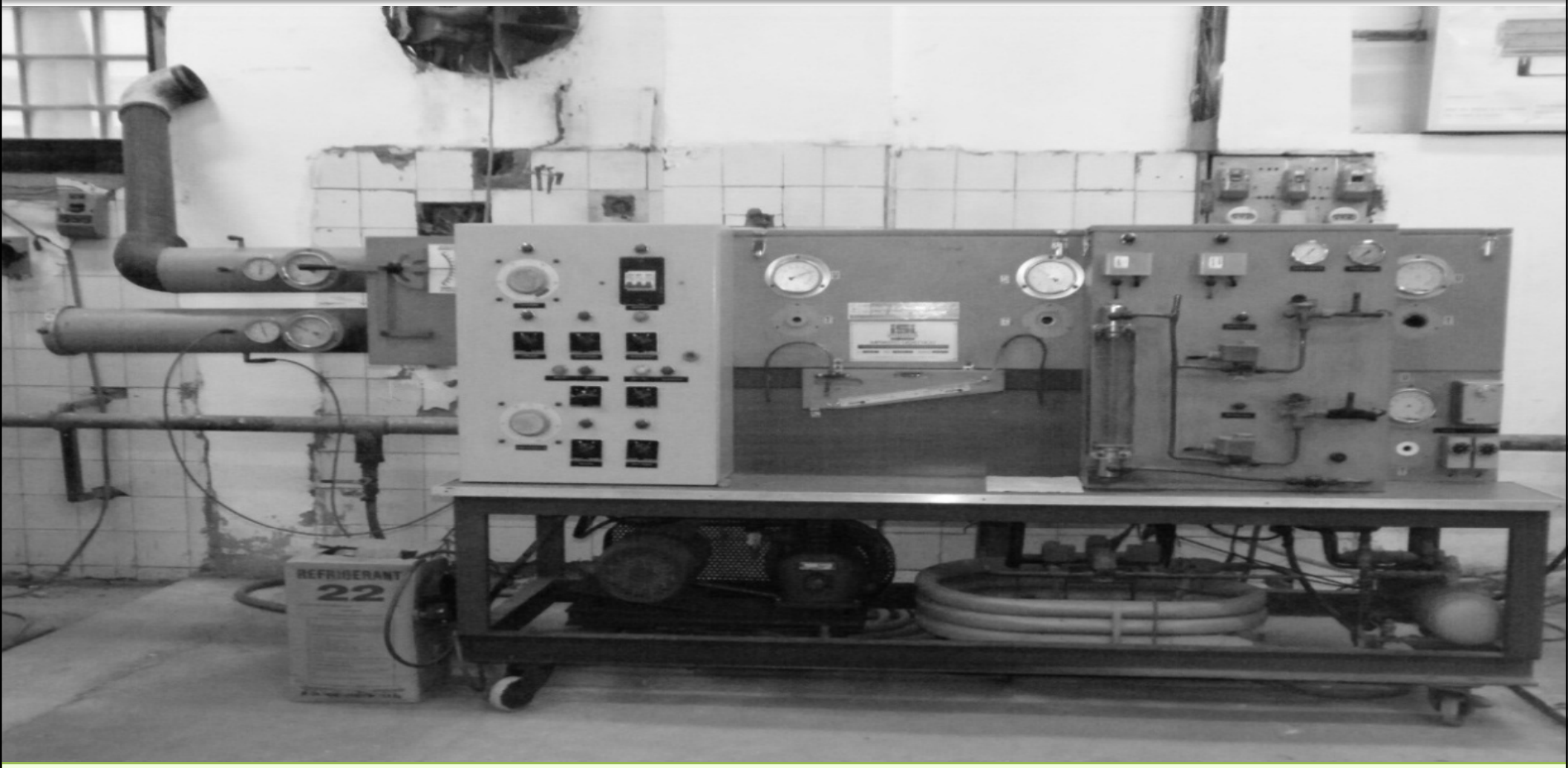
ILO's of MEP 571- Applications of VLabs in Automatic Control of Industrial Air-conditioning Plant :

- Identifying main concepts of industrial automatic control systems in many mech. power applications by modern PC-based Virtual Lab programs which simulate those practical control systems.
- Investigation of many Air-conditioning control processes to understand their functions, how they work and what are their input & output signals …etc.

Studying all related governing conversation eqns in the Air-conditioning control processes .•

- Verification of the accuracy and validity of the results obtained by this virtual lab through performing engineering and scientific calibrations for this virtual lab. The calibration is done by comparing internal calculations done by this virtual lab with your external engineering calculations using thermo-dynamic, conservation equations, &thermo-fluid relations to get same output results.
- Training Engineers on Technical Report Writing &Presentation Skills for this Air-Conditioning Lab.
- Enhancing the skills of Searching for information and adopting self learning capabilities related to Air-conditioning Automatic systems and modern computer technologies.

Evaluation of Air Handling Unit مقارنة مع البرنامج: جزء إضافي على خطوات تنفيذ تجربة عملية لتشغيل ومعايرة وحدة مناولة الهواء



Objective of this Part: The Aim of this experiment is to analyze and investigate the main components of an actual, training and industrial air handling unit (AHU) and to operate the necessary components to achieve the required comfort of the conditioned space as specified by the control system.

Over view: Air Handling Unit (AHU) is one of the air conditioning systems. It is a collection of components which treat the incoming air by providing the required ventilation, air flow rate, and achieving the required supply conditions to the served zone. The AHU is designed to treat the air though the whole year, so it contains the components that can perform: cooling, heating, humidification, and dehumidification. AHU's size depends on the load of zone(s) which affect the components size.

Course Specifications & Basic Information

1. Title:	Using Virtual Lab Applications for Control of Air-Conditioning (HVAC) plant			Code:MEP571
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 an elective course as one of the 4 elective courses requirements of the Diploma. It is designed to review the essentials of HVAC processes as important applications of mechanical power systems. It is designed also to enhance the skills and give the participant a broad based understanding of the most important concepts of practical automatic control and real thermo-fluid processes of industrial HVAC plant used to air-condition a building to some pre-specified dry-bulb temperature and relative humidity. The course uses the Virtual Lab method by a practical on-line interactive PC program. This automatic control Virtual Lab is E-self-learning type software. The course includes a large number of practical examples and problems for HVAC systems and processes. This Virtual Lab program along with the course notes & sheets provide a typical example for modern self-e-learning education techniques for studying and analyzing various aspects related to applications of automatic control of HVAC systems.

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, various definitions & terminologies associated with HVAC processes & control systems.
-Requirements of general interactive virtual lab program to study & analyze HVAC control systems.
-Basics of on-line interactive virtual lab to study and analyze HVAC control circuits/systems.
-Essential components of HVAC circuits as important application of mechanical power systems.
-Basics and main concepts of HVAC processes, functions and how to perform them, and what their inputs and outputs signals are?
-Governing conservation equations of the HVAC automatic control processes.
-Analysis of industrial HVAC automatic control systems by using modern PC-based Virtual lab program to simulate actual processes performed in real HVAC automatic control systems.
-Main requirements of on-line chart plotting module for real psychometric diagram plotting to show all performed HVAC processes.
-Structure, main components, various menus & submenus of HVAC automatic control Virtual lab.
-Control parameters, Synoptic diagram, flow paths, instrumentation & control boards of HVAC Virtual Lab.
- Verification and engineering calibration of the outputs of a HVAC automatic control virtual lab program

-b) Intellectual Skills:

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

-Select and apply appropriate technical and optimum method in doing engineering design and analysis of automatic control problems.

-Searching for scientific information and adopting automatic control self-E-learning capabilities.

-Analyze and compare the component effects, performance, and efficiency of different types of automatic control HVAC systems.

-Apply the concept of software simulation of diagnostics & operation of various types of practical HVAC systems.

-Compare between various types of HVAC processes, components, and complete systems.

-Select and apply appropriate HVAC processes, components to design, model, analyze, and solve automatic HVAC control problems.

c) Professional and Practical Skills:

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

-Identify several types of automatic HVAC control problems which are essential for design and operation of mechanical power systems and energy transfer processes.

-Perform professional design and modelling for different automatic HVAC control systems.

-Suggest possible alternative solutions for various types of HVAC components and parts.

-Diagnose efficiency and performance of different types of HVAC control circuits/systems.

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.