Cairo University
Faculty of Engineering
Mech. Power Department
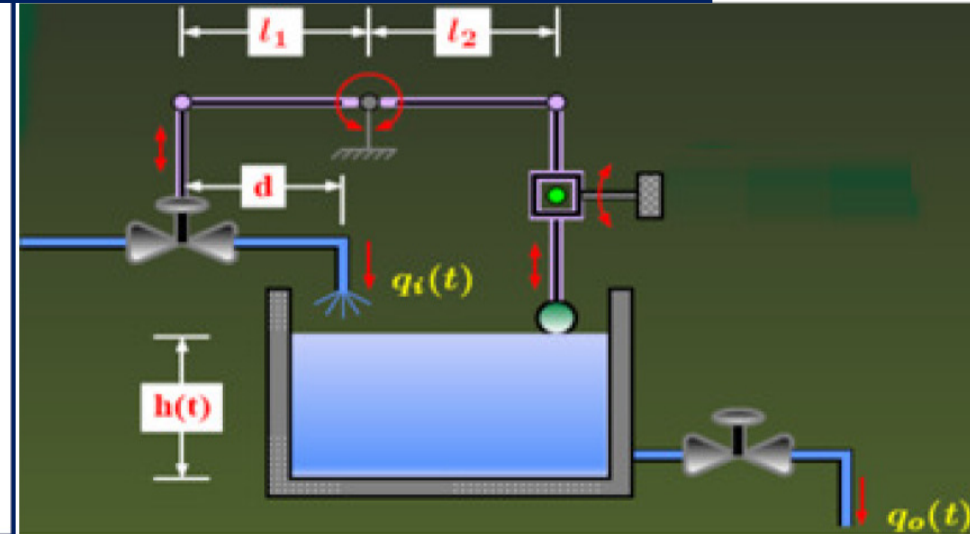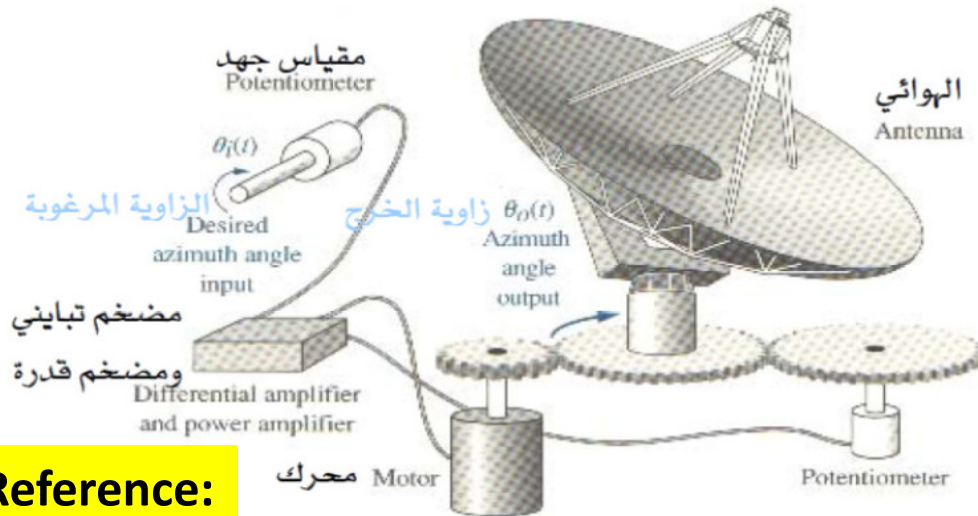
GAIRO UNIVERSITY
FACULTY OF ENGINEERING

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 561 Control Theory

Dr. Mohsen Soliman, ACC Manager

أنظمة التحكم الأوتوماتيكى
– النظرية والتطبيق –

مقياس جهد
Potentiometer

$\theta_i(t)$

الزاوية المرغوبة
Desired azimuth angle input

الهوائي
Antenna

$\theta_o(t)$
زاوية الخرج
Azimuth angle output

مضخم تبايني
ومضخم قدرة
Differential amplifier
and power amplifier

محرك Motor

Potentiometer

l_1 l_2

d

$q_i(t)$

h(t)

$q_o(t)$

Reference:

MODERN CONTROL ENGINEERING
Katsuhiko Ogata
FIFTH EDITION

MEP 561- Basics of Control Theory (and Examples of Process Control Applications)

إسم المقرر- مكق 561 التحكم الأوتوماتيكى- النظرية والتطبيق فى نظم القوى الميكانيكية:

محتوى وأهداف الجزء الأول: وصف وتعريف أنواع نظم التحكم، تحديد المكونـات الميكانيكيـة والهوائيـة والهيدروليكيـة والكهربائية،تحديد طرق النمذجة ودالة التحويل، وصف النظام ذوالحلقة المغلقة، تحديد الاستجابة الوقتية، وصف إختبارالاتزان والإستقرار.

Contents of Part one: Types of Control Systems – Mechanical components, pneumatic, hydraulic, electric systems – Modeling – Transfer function – Closed loop system – Instantaneous response – Stability and equilibrium tests – Design of control systems – Applications of control systems in turbo-machines, heat transfer equipments and in combustion systems.

محتوى وأهداف الجزءالثانى (مكق 581 –إختيارى-موضوعات مختارة وتطبيقات عملية فى نظم التحكم): وصف تصميم نظم التحكم، وصف ودراسة وتحليل عناصر التحكم فى بعض التطبيقات في خطوط الأنابيب والآلات التوربينية ومعدات إنتقال الحرارة ونظم الإحتراق....إلخ

محتويات الجزء الأول – الوحدة الثانية تدخل فى مقرر مكق 560: أجهزة القياسات والإختبارات   Part (1) -

Course Specifications & Basic Information			
1. Title:	**Basics of Control Theory**		**Code:MEP561**
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: <u>Overall Aims:</u>

This is a mandatory course as one of the 6 mandatory core courses of the Diploma. It is designed to show the basic concepts and essentials of automatic control theory as it is applied on mechanical power systems and heat and mass transfer processes. The course include large numbers of practical examples and problems on various types of control systems to enhance students professional skills in the field of modeling & analyzing real automatic control systems.

Course overall aims is to define automatic control theory and the associated terminology- introduce and study various types of Control Systems– Mechanical components, pneumatic, hydraulic, electric systems–Mathematical Modeling of control systems–Laplace and the inverse Laplace transformations-Element and System Transfer functions – Close and open loop systems –Instantaneous system response–system stability & equilibrium tests –Design of control systems – Practical applications of automatic control theory in different mechanical power and heat transfer and mass transfer processes and equipments.

2. Intended Learning Outcomes of Course (ILOs):

<u>a) Knowledge and Understanding:</u>

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

- Basics and various definitions and terminologies associated with automatic control theory.

- Various types of automatic control loops in mechanical power and energy transfer systems.

-Essential requirements of accuracy, efficiency, safety, and stability of automatic control systems

-Concepts of mathematical modelling of various mech. power systems & energy transfer processes

-The element and the whole system transfer functions, and Block diagram analysis method.

-Laplace Transform & inverse Laplace technique to solve system's ordinary time-dependent differential equations.

- Instantaneous dynamic response of control system and its graphical presentation on an output-time scale for various types of different input testing functions.

-Main definitions and control characteristics of dynamic response of 1st and 2nd order automatic control systems.

- The analogy between various types of mechanical control systems and electric control systems.

–Practical applications of automatic control theory in different mechanical power and heat transfer and mass transfer processes and equipments.

-b) Intellectual Skills:

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

-Select and apply appropriate mathematical and technical methods to model, analyze, and solve automatic control problems.

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

- Analyze& compare performance and time response of different types of ordinary time-dependent differential equations of control systems.

-Solve numerical and practical examples on automatic control systems.

-Apply scientific and engineering analysis for different mechanical power control systems.

-Apply and use Laplace Transform and inverse Laplace tables for mathematical modeling, block diagram reduction and for solving the system's ordinary time-dependent differential equations.

c) Professional and Practical Skills:

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

-Identify several types of automatic 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 control systems.

-Suggest possible alternative solutions for various types of automatic control systems.

-Use & apply different tables and equations for Laplace and inverse Laplace Transformations.

-Diagnose stability and dynamic response problems of automatic control of mechanical power systems and energy transfer equipments.

- Formulate and analyze heat transfer and fluid flow practical problem related to control fields.

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.