Course Specifications

Program on which this course is given:	**Diploma of Applications of Automatic Control of Mech. Power Systems**
Department offering the program:	**Mechanical Power Engineering Department - ACC control Lab**
Department offering the course:	**Mechanical Power Engineering Department - ACC control Lab**
Academic Level:	**Elective Course - Summer Term of the Diploma of Graduate Studies**
Date	**1st Term 2022/2023**
Semester (based on final exam timing)	☐√ Fall Spring Summer

A- Basic Information

1. Title:	**Selected Topics of Industrial Pipe Lines (Compressible Flow or Gas Dynamics)**						**Code:**	**MEP 580**
2. Units/Credit hrs per week:	**Lectures**	**3 Credit hours per week**	**Tutorial**	**--**	**Practical**	**--**	**Total**	**3**

B- Professional Information

1. Course description	**Overall Aims:** **This practical elective course is one of the 4 elective courses requirements of the Diploma. It is designed to review, effectively, Basic Design Concepts & Fundamental Aspects of Compressible Flow or Gas Dynamics in Piping Systems. Compressible flow occurs in many piping systems and devices. Knowledge of effects of compressibility on pipeline flow is therefore very important. Our purpose is to expand & extend basic analysis given in thermodynamics & fluid mechanics courses to cover in more details some Gas dynamics or compressible flow. The main objective is to give students the skills & basic knowledge to understand the main differences between incompressible & compressible flow types in both variable area and constant area ducts (or pipes). This Course aims also to provide students with a clear explanation of physical phenomena which encountered in compressible flow, to develop in them awareness of practical situations in which compressibility effects are likely to be very important, to provide a though explanation of the assumptions used in the analysis of compressible flow, to provide a broad coverage of the subject of compressible flow in both variable & constant area ducts. One final goal is to provide a firm foundation for the study of more advanced and specialized aspects of the Gas Dynamics.**
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:** **- Essential facts, fundamentals, concepts and principles of compressible flow or Gas Dynamics.** **- Definition & physical meaning of Speed of sound, Mach number and Mach Cone concepts.** **-Concepts of stagnation reference properties and critical reference properties in Gas Dynamics.** **-Derivation of and constraints of basic governing conservation equations (mass, linear momentum and energy) for compressible flow to reach at an optimum solution.** **-Basic analysis of 1-D isentropic flow in converging, diverging or converging-diverging ducts.** **- Difference between Chocking of flow at a throat and Normal Shock Wave in supersonic flow.** **-The form and methodology of analysis for some practical examples in 1-D isentropic flows in variable area ducts.** **-Why it is impossible to have an isentropic compressible flow in a constant area duct or a pipe?** **-Basic analysis of 1-D adiabatic flow with wall friction in a pipe which is called Fanno Line Flow.** **-Basic analysis of 1-D isothermal flow with wall friction in a pipe.** **-Analysis of 1-D Frictionless flow with heat transfer across the wall which is called Rayleigh Line .** **-Basic analysis of Normal Shock Wave in all cases of supersonic flow in a constant area duct.**

b) Intellectual Skills:

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

-Select appropriate 1-D approximation analysis for solving some real compressible flow problems.
-Select and apply appropriate technical and optimum method in doing engineering design and analysis of compressible flow in both variable and constant area ducts.
- Apply appropriate analytical tools & concepts of Mach Number, subsonic, sonic and supersonic flows to solve various gas dynamics problems to meet certain needs.
- Analyze and interpret data from empirical equations, tables & charts to solve practical problems for real compressible flow in both variable and constant area ducts.
-Apply scientific and engineering analysis for compressible flow in pipeline systems and networks.

c) Professional and Practical Skills:

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

-Identify several types of compressible flow problems in pipe line systems which are essential for the design and operation of mechanical power systems and energy transfer processes.
-Perform professional design and modelling for compressible flow problems of pipe line systems.
-Suggest possible alternative solutions for various types of compressible flow in pipe line systems.
- Apply Gas dynamics equations to deal with applied practical engineering problems such as gas flow in both variable and constant area ducts.
- Analyze different types of automatic control problems in pipe line systems and networks.
- Search for information related to compressible flow problems relevant to gas dynamics.
- Prepare and present informative and neat technical reports.

d) General and Transferable Skills:

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

-Perform engineering assembly of different pipe line system fittings and networks components in one control system.
-Transfer knowledge, Work in group and Communicate in written and 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 and compare between different technologies used for pipe line systems and networks.
-Organise & manage time & resources effectively; for short-term and longer-term commitments.

3. Contents

Topics:	Total hrs	Lectures hours	Tutorial/ Practical hrs
Introduction and Basic Concepts of Gas Dynamics (compressible flow): **-Speed of sound, Mach number, Stagnation Reference properties and Critical Reference properties.** **- Equations of steady 1-D isentropic flow with area changes.** **- Isentropic flow in a converging nozzle** **- Normal Shock Wave equations, Flow in a converging-diverging nozzle** **- One-Dimensional adiabatic flow in constant area duct with wall friction.** **- Iso-thermal flow in constant area duct with wall friction.** **- Frictionless flow with heat transfer across the wall.** **- Normal Shock Wave in all cases of supersonic flow in a constant area duct.**	**42 hrs**	**3hrs/week for 14 weeks before the final term exam**	---

4. Teaching and Learning Methods

Lectures (√)	Practical/ Training (√)	Seminar/ Workshop ( )	Class Activity (√)	Case Study (√)	Projects ( )	Laboratory ( )	E-learning (√)	Assignments /Homework (√)	Other: Submitting reports

5. Student Assessment Methods

Assessment Schedule	Week
-Assessment 1; Report # A	Week # 1
-Assessment 2; Report # B	Week # 2
-Assessment 3; Report # C	Week # 4
-Assessment 4; Report # 1	Week # 6
-Assessment 5; Report # 2	Week # 8
-Assessment 6; Report # 3	Week # 10
-Assessment 7; Report # 4	Week # 12
-Assessment 8; Report # 5	Week # 13
-Assessment 9; – General course Report	Week # 14

- **Weighting of Assessments**

-All in-term works, sheets and reports	30%
-Final-term formal, written Examination	70%
-Project	--
-Class Test	--
-Presentation	--
-Total	100%

6. List of References:

1- Several class notes, presentations & Special Reports prepared by Assoc. Professor Dr. Mohsen S. Soliman.
2- "Compressible Fluid Flow", Patrick H. Oosthuizen &William E. Carscallen, MCGRAW-HILL Series in Aeronautical and Aerospace Engineering, 1997
3- "Fluid Mechanics", 4th ed., Frank M. White, MCGRAW-HILL, N.Y.
4- "Mechanical Engineering HandBook", CRCnetBase1999, Frank Kreith,CRC Press.
5-"Piping Hand Book", Mohinder L.N., 7th Edition, MCGRAW-HILL, N.Y.

7. Facilities Required for Teaching and Learning: Data Show & Laptop Computer to run the Virtual Lab.

Course Coordinator:	Associate Professor Dr. Mohsen S. Soliman
Head of Department:	Professor Sayed Ahmed Kaseb

Date September 2022