# Course Specifications

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| **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 - 1st Term of the Diploma of Graduate Studies** |
| **Date** | **1st Term 2017/2018** |
| **Semester (based on final exam timing)** | √ Fall ☐ |

## A- Basic Information

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| **1. Title:** | **Fluid Dynamics and its Applications** | | | | | **Code:** | **MEP 588** |
| **2. Units/Credit hrs per week:** | **Lectures** | **3 Credit hours per week** | **Tutorial** | **--** | **Practical** | **--** | **Total** **3** |

## B- Professional Information

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| **1. Course description:** | **Overall Aims**: This elective course is designed to review both the Integral and Differential general governing equations for fluid motion. The review essentially covers incompressible flow. The course also reviews basic concepts and elements of compressible flow (Gas Dynamics). Typical applications are shown for both cases including compressible flow in pipe lines and Boundary Layer flow. Boundary Layer Control is also discussed. An introduction to turbulence is also given. |
| **2. Intended Learning Outcomes of Course (ILOs):** | **a) Knowledge and Understanding:** Having successfully completed this course, the student should be able to demonstrate knowledge and understanding of:<br>1. Essential facts and concepts relevant to various types of fluid flows in comparison with different types of fluids.<br>2. The derivation of and constraints of basic governing conservation equations (mass, linear momentum and energy) for a differential control volume in comparison with similar Integral control volume equations to reach at an optimum solution.<br>3. Concepts and theories of the Integral control volume analysis versus the differential control volume equations.<br>4. Physical meaning, impact and weight of each term in fluid flow Integral and Differential equations.<br>5. The role and importance of viscous effects in different types of fluid flows.<br>6. The form & methodology of solving the non-linear differential equations of boundary layer flow.<br>7. Essential facts, fundamentals, concepts and principles of compressible flow (Gas Dynamics).<br>8. The derivation of and constraints of basic governing conservation equations (mass, linear momentum & energy) for compressible flow to reach at an optimum solution.<br>9.The form and methodology of analysis for some practical examples in 1-D flows in both variable area and constant area ducts.<br><br>**b) Intellectual Skills:** Having successfully completed the course, the student should have the ability to:<br>1. Select and analyze the differential equations in various coordinate-systems (Cartisine, cylindrical and spherical forms) suitable for the flow examined.<br>2. Select and solve basic and simple types of incompressible-viscous flow problems .<br>3. Think in a creative and innovative way in problem solving by introducing concept of solution batching to link frictionless flow region to boundary layer viscous flow region in the real flow field problems.<br>4. Analyze the results of numerical models to solve Boundary Layer flow equations and acknowledge their limitations.<br>5. Use the principles of many engineering sciences in developing creative solutions to applied and practical fluid flow and heat and mass transfer Problems.<br>6. Create and follow organized scientific methodology when dealing with various fluid applications.<br>7. Select appropriate 1-D approximation analysis for solving some real gas flow problems.<br>8. Apply appropriate analytical tools and concepts of Mach Number, subsonic, sonic and supersonic flows to solve various gas dynamics problems to meet certain needs. |

**c) Professional and Practical Skills:**

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

1. Apply fluid dynamics to deal with some important problems such as lubrication in bearings and Gas dynamics flow in pipelines.
2. Use various types of tables/charts/equations of Gas Dynamics and Boundary Layer flow and determine their accuracy and validity.
3. Compute and Introduce different types of numerical solution techniques to solve differential equations such as using stream function method for frictionless flow and Blasius Solution for the boundary layer flow analysis.
4. Apply numerical modeling methods and/or appropriate computational techniques to solve applied and practical fluid flow and heat and mass transfer Problems.
5. Use computational tools/CFD packages and computer programs and use appropriate ICT tools pertaining to various solutions of 2-D potential flow and Boundary Layer flow problems.
6. Search for information related to a variety of fluid flow problems.
7. Make an engineering design for fluid applications based on the understanding of the main concepts.
8. Work in mechanical power and energy operations.
9. Exchange knowledge with engineering community.
10. 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 do:

1. Work in stressful environment and within constraints.
2. Communicate effectively.
3. Demonstrate efficient IT capabilities to prepare Report assignments.
4. Effectively manage tasks and resources.
5. Search for information and adopt life-long self learning.
6. Refer to relevant literature.

**3. Contents**

| Topics: | Total hrs | Lectures hrs | Tutorial Practica hrs |
|---|---|---|---|
| **Part-1**: Review of Integral and Differential equation of mass conservation<br>Driving Navier-Stokes equations (linear momentum) for Newtonian fluids, angular momentum and energy eqns. Viscous flow in pipes and ducts. Flow between parallel plates with pressure gradients. Differential equations for frictionless flow (Euler's eqns.)<br>Stream and potential functions, vorticity, irrotationality, elementary plane-flow solutions. Superposition of plane-flows and Images<br>**Part-2:** Introduction to Boundary Layer flows, the differential equations, Exact equations for 2-D flow. Blasius exact solution for laminar flow, the Momentum Integral equations. Approximate solutions for 2-D laminar and turbulent boundary layers. Boundary Layer Control.<br>**Part-3:** Introduction to Gas Dynamics (compressible flow), Basic concepts: Speed of sound, Mach number, Stagnation properties and Critical 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. 1-D 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. | **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 |
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**Also for Teaching and Learning:**

- Lectures and problem solving in tutorial classes.
- Information collection from text material, class notes and the Internet sites.
- Report and research assignments. Three assignment Sheets (1, 2 and 3)
- Group discussions in lectures.
- Hand-outs materials.

**5. Student Assessment Methods**

| Assessment Schedule | Week |
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| -Assessment 1; Report # 1 | Week # 1 |
| -Assessment 2; Report # 2 | Week # 3 |
| -Assessment 3; Report # 3 | Week # 5 |
| -Assessment 4; Report # 4 | Week # 7 |
| -Assessment 5; Report # 5 | Week # 9 |
| -Assessment 6; Report # 6 | Week # 10 |
| -Assessment 7; Report # 7 | Week # 11 |
| -Assessment 8; Report # 8 | Week # 12 |
| -Assessment 9; Report # 9–General course Report | Week # 14 |

- **Weighting of Assessments**

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

**6. . List of References**

- Course Notes: Compiled Notes corresponding to different course sections
- Essential Books (Text Books):

1- B.R. Munson, D. F. Young, and T. H. Okishi, “*Fundamentals of Fluid Mechanics*”, John Wiley & Sons, Inc., New York, 4th Edition (2002).

- Recommended Books:

1- Frank M. White “Fluid Mechanics”, 2nd ed., McGraw Hill, 1986.
2- R.W.Fox & A.T.McDonald “Introd. to Fluid Mechanics”, 3rd ed., John Wiley & Sons, 1989
- Hand-outs and Web Sites information,… etc

**7. Facilities Required for Teaching and Learning: Data Show and Laptop Computer**

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

**Date September 2017**