**DEPARTMENT OF AERONAUTICAL ENGINEERING**
**COURSE SYLLABUS**

**AE 413: Viscous Flow**

| COURSE TITLE | ENGLISH CODE/NO | ARABIC CODE/NO. | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Total |
| **Viscous Flow** | AE 413 | 413 هـ ط | 3 | 1 | | 3 |
| ***Pre-requisites:*** | AE 311 | | | | | |
| ***Course Role in Curriculum*** *(Required/Elective):* | Elective Course | | | | | |
| ***Catalogue Description:*** Review of conservation equations. Simple problems of viscous flow, Thin films flows, Creeping flow, Low Reynolds number flow, High Reynolds number turbulent flow, Convective heat transfer, Basics of numerical simulation of fluid flow, Solving viscous flow problems using Fluent. | | | | | | |

***Textbooks*:** (Author, Title, Pub., year)
Papanastasiou, T.C.; **Viscous Fluid Flow**, 1999, 1st Edition CRC Press.

***Supplemental Materials*:**
1. White, F.M.; **Viscous Fluid Flow**. 3rd Edition, 2005, McGraw-Hill Inc
2. Martha L. Abell and James P. Braselton; Maple by Example. 3rd Edition, 2005, Elsevier Inc.

***Course Learning Outcomes*:**
By the completion of the course the students should be able to:

1. Derive governing equation for fluid flow problems.
2. Develop mathematical model for fluid flow problems .
3. Develop exact solutions for a range of practical engineering problems.
4. Describe qualitatively and quantitatively both laminar and turbulent boundary layers in terms of their thickness, velocity profiles and shear stress variation along a surface.
5. Identify factors affecting transitions, means to identify transition and techniques to enhance or delay transition.
6. Use statistical techniques to develop time-averaged Navier-Stokes equations relevant to turbulent flows.
7 Relate Reynolds stresses with mean velocity gradient, mixing length hypothesis etc.
8. Differentiate between free and wall-bounded shear flows.
9. Analyze viscous flows involving forced convection.
10. Analyze viscous flows involving Natural convection.
11. Use FLUENT to study and analyze viscous fluid flow problems.

| ***Topics to be Covered:*** | | ***Duration in Weeks*** |
|---|---|---|
| 1. | Introduction | 1 |
| 2. | Exact Solutions of Navier-Stokes Equations | 3 |
| 3. | Incompressible Turbulent Flow | 4 |
| 4. | Convective Heat Transfer | 3 |
| 5. | Fluent | 3 |

***Student Outcomes addressed by the course:*** (Put a ✓ sign)

| | | |
|---|---|---|
| (a) | an ability to apply knowledge of mathematics, science, and engineering | ✓ |
| (b) | an ability to design and conduct experiments, as well as to analyze and interpret data | |
| (c) | an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | |
| (d) | an ability to function on multidisciplinary teams | |
| (e) | an ability to identify, formulate, and solve engineering problems | ✓ |
| (f) | an understanding of professional and ethical responsibility | |
| (g) | an ability to communicate effectively | |
| (h) | the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | |
| (i) | a recognition of the need for, and an ability to engage in life-long learning | |
| (j) | a knowledge of contemporary issues | |
| (k) | an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. | ✓ |

***Key Student Outcomes assessed in the course***: **(e) and (k)**

***Instructor or course coordinator:*** Dr. Ibraheem AlQadi
***Last updated:*** May 2015