Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

Shuja ur Rehman

will give a presentation, entitled:

Numerical Simulation of Flow about Airfoil with Synthetic Jet actuation

Date: Thursday August 29, 2013

Time: 14:00

Room: **ZH.286**

Summary:
An airfoil is an essential part of a lifting body contributing the major portion of the lift produced. This can be in the form of the wings of an airplane or the blades of a wind turbine. At high angle of attack, the flow over the airfoil separates at a point on upper surface of the airfoil. The flow separation causes a decrease in the aerodynamic performance of the airfoil, i.e. a decrease in the lift coefficient and an increase in the drag coefficient. In order to enhance the aerodynamic performance of an airfoil it is desirable to control the flow separation on the airfoil.

Synthetic Jet Actuator (SJA) is one of the methods used to control flow separation. During the suction phase of a cycle of the SJA low momentum air of the boundary layer is inhaled. Subsequently during the blowing phase of the cycle the SJA ejects this air through a slot forming a jet which injects momentum into the boundary layer. Therefore the SJA is a zero-net-mass-flux device, not requiring feeding lines like a continuous or intermittent jet device. The purpose of the current research is to study flow separation control for a NACA-0018 airfoil at high angle of attack using synthetic jet actuators with the jet oriented normal to the surface of the airfoil.

To gain insight into the performance of an SJA before embedding it in the airfoil, a study has been carried out on a synthetic jet ejecting into quiescent air through numerical simulations of the flow using CFD. The effect of varying the orifice width and the width of the internal cavity on the performance of the SJA has been studied. Furthermore, the performance of an SJA with sharp internal edges has been compared with the performance of an SJA with a smooth-edged inner orifice.

Numerical simulations have been carried out for the two-dimensional flow about a NACA-0018 airfoil, chord of 2.37m, at 17^o angle of attack, in a free stream of 19.4 m/s, corresponding to a Reynolds number of $Re = 3.15 \times 10^6$. The synthetic jet is embedded at 67% of the chord. The analysis has been carried out for a reduced frequency of $F^+ = 1.25$ (25 Hz) and a momentum coefficient of $C_\mu = 0.0015$. It is found that the SJA decreases the lift coefficient and increases the drag coefficient of the airfoil, i.e. for this two-dimensional flow it acts as a spoiler.
For the case of three-dimensional flow the lift coefficient is found to be increased by 5.21%. Finally, the effect of higher reduced frequency and higher momentum coefficient C_μ on the performance has also been studied.

Assessment committee: **Chairman,**

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