THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

MAY – JULY 2018 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE

SUPPLEMENTARY EXAMINATION

MAT 604: FLUID IV

Date: JULY 2018	Duration: 3 Hours
INSTRUCTIONS: Answer any THREE Questions	

Q1. a) Identify and derive the equation below for two dimensional compressible flow.

$$\frac{d}{dx}\int_0^{\delta_1} \rho u c_p (T_1 - T)dy + \frac{d(C_pT)}{dx} Q\int_0^{\delta_1} u(\rho_1 - \rho)dy + \int_0^{\delta_1} \mu\left(\frac{\partial u}{\partial y}\right)^2 dy = Q_w$$

(15marks)

b) Use your results in (a) to obtain an approximate solution of the boundary layer problem. **(8marks)**

Q2. Discuss Pohlhausen's method of exact solution for the velocity and thermal boundary layers in free convection from a heated vertical plate and use this to establish the relationship between the dimensionless numbers, Prandtl $(\Pr)$,local Nusselt (N_u),and Grashon (G_r). **(23marks)**

Q3. a) Show that for an incompressible steady flow with constant viscosity ,the velocity components

$u(y) = y\frac{U}{h} + \frac{h^2}{2\mu}(-\frac{dp}{dx})\frac{y}{h}\left(1 - \frac{y}{h}\right), v = w = 0$ Satisfy the equation of motion,

when the body force is neglected $h, U, \frac{dp}{dx}$ are constants and p=p(x)

(15marks)

b) Consider the case of simple Coutte flow with velocity and temperature distribution as follows

$$u = {U_y}/{h}, v = 0, p = 0 \qquad \text{(i)}$$

$$\frac{T - T_w}{T_\infty - T_w} = \frac{y}{h} + \frac{\mu v^2}{2k(T_\infty - T_w)}\left(\frac{y}{h}\right)\left(1 - \frac{y}{h}\right) \qquad \text{(ii)}$$

Where T_w *and* T are temperatures (constant value) of stationary and moving plate ,respectively and μ, h *and* k are constants.Verify that (i)and (ii) are the solutions of the energy equation for steady viscous compressible fluid. **(8marks)**

Q4. Derive the Crocco's first and second integral in forced convection in a laminar boundary layer on a flat plate. **(23 marks)**

Q5. Discuss laminar free convection flow of an incompressible viscous fluid from a heated vertical plate and derive the expression of the local Nusselt number. **(23marks)**

END