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MAIN EXAMINATION

MAY – JULY 2018 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE

PART TIME PROGRAMME

MAT 331: FLUID MECHANICS I

Date: JULY 2018	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and any other TWO Questions	

Q1. a) Define the following terms
i) A fluid **(2marks)**
ii) Steady and unsteady flows **(2marks)**

b) Write the dimensions of the following quantities
i) Pressure
ii) Density **(3marks)**
iii) Acceleration

c) Derive the equation of stream line. Hence find the stream lines and path lines of the particle when $u = \frac{x}{(1+t)}$ $v = \frac{y}{(1+t)}$ $w = \frac{z}{(1+t)}$ **(12marks)**

d) A fluid flow is given by $\boldsymbol{q} = xy\, i + 2yz\, j - (yz + z^2)$k. Determine whether this is a possible steady incompressible flow. **(5marks)**

f) A velocity field is given by $= \frac{k^2(-iy+jx)}{(x^2+y^2)}$. Determine whether the flow is rotational or irrotational. **(6marks)**

Q2. a) Show that $u = \frac{-2xyz}{(x^2+y^2)^2}$, $v = \frac{(x^2-y^2)z}{(x^2+y^2)^2}$ $w = \frac{y}{x^2+y^2}$ are the velocity components of a possible liquid motion. Finally check if the motion is irrotational **(15 marks)**

b) State the second law of thermodynamics and explain the efficiency of Carnot engine. **(5marks)**

Q3. a) State the first law of thermodynamics and hence prove that $pv^{\gamma} = constant$ where the symbols have their usual meaning. **(10 marks)**

b) Show that the variable ellipsoid $\frac{x^2}{a^2k^2t^4} + kt^2\left(\frac{y^2}{b^2} + \frac{z^2}{c^2}\right) = 1$ is a possible form of boundary surface of a liquid at time t. **(10marks)**

Q4. a) Air obeying Boyle's law, is in motion in a uniform tube of small section, prove that if ρ be density and v be the velocity at a distance x from a fixed point at time t

$\frac{\partial^2 \rho}{\partial t^2} = \frac{\partial^2}{\partial x^2}\{(v^2 + k)\rho\}$ Where $k = \frac{p}{\rho}$ **(10 marks)**

b) Derive the Bernoulli's equation

$\frac{1}{2}q^2 + \Omega + \int \frac{dp}{\rho} = 0$ **(10 marks)**

Q5. i) State Kevin's circulation theorem **(4marks)**

ii) Velocity vector is given by $\boldsymbol{q} = \frac{k^2(-iy+jx)}{(x^2+y^2)}$. Determine whether the flow is irrotational. **(4marks)**

iii) Calculate the circulation round a square with corners at (1,0) , (2,0),(2,1),(1,1). **(12 marks)**

END