KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

INSTITUTIONAL BASED PROGRAMME (IBP) – DECEMBER SESSION

EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE

SMA 533: FLUID MECHANICS II

DATE: Friday, 4th May, 2012 TIME: 9.00 a.m. – 12.00 p.m.

INSTRUCTIONS:

Answer any **THREE** questions.

Q.1 a) i) Define the Karman Vortex Street.

ii) A flow is composed of a single infinite row of vortices each of strength *k* at the points $z = 0, \pm a, \pm 2a, ..., \pm na, ...$ Show that $w = \frac{ik}{2\pi} \ln Sin\left(\frac{\pi z}{a}\right)$ and hence find the components of velocity. (10 marks)

b) Discuss the Magnus effect using suitable illustration. (8 marks)

c) i) Briefly discuss similarity.

ii) An airship of 3m diameter and 20m length is to be studied in a wind tunnel. The airship speed range to be investigated is at the docking end of its range, a maximum of $2ms^{-1}$. Calculate the mean wind tunnel speed if the model is made to $1/10$ scale. Assume the same air pressure and temperature for the model and prototype. (5 marks)

Q.2 a) State the theorem of Blasius and derive expressions for he force components $[X, Y]$ and couple *M* on the cylinder due to the action of the fluid. (15 marks)

b) A flow consists of an infinite cylinder with circulation. Determine the components of force $[X, Y]$ and the couple M acting on the cylinder.

(8 marks)

Q.3 a) A vortex of circulation $2\pi k$ is at rest at the point $z = na\ (n>1)$, in the presence of a plane circular boundary $|z| = a$, around which there is a circulation $2\pi\lambda k$.

i) Show that $\lambda = 1/(n^2 - 1)$

ii) Show that there are two stagnation points on the circular boundary $z = ae^{1\theta}$, symmetrically placed about the real axis in the quadrants nearest to the vortex, given by $\cos\theta = \dfrac{(3n^2 - 1)}{2n^3}$. (13 marks)

b) Discuss the optimum shape of cross-section for uniform flow in open channels. (10 marks)

Q.4 a) Find the proportions of a trapezoidal channel (Fig.1) which will make discharge a maximum for a given cross-sectional area of flow and given side slopes. Show also that if the side slopes can be varied the most efficient of all trapezoidal sections is a half hexagon.

(13 marks)

b) A trapezoidal section has side slopes of 3 horizontal and 4 vertical and the slope of its bed is 1 in 2000. Determine the optimum dimensions of the channel if it is to carry water at 0.5 m^3s^{-1}. (10 marks)

Q.5 a) Discuss briefly the following topics:-

i) Dimensional analysis

ii) Dimensional reasoning

iii) Dimensionless quantities

(12 marks)

b) The variables controlling the motion of a floating vessel through water are the drag force F, the speed *v*, the length *l*, the density ρ and dynamic viscosity μ of the water and the acceleration *g*. Derive an expression for F by dimensional analysis. (11 marks)