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**University Examinations 2012/2013**

FIRST YEAR, THIRD SEMESTER EXAMINATION FOR MASTER OF SCIENCE IN APPLIED MATHEMATICS

**SMA 3140: FLUID MECHANICS III**

**DATE: DECEMBER 2012** **TIME: 3HOURS**

**INSTRUCTIONS:** *Answer questions* ***one*** *and any other* ***two*** *questions*

- **The symbols have their usual meaning**

**QUESTION ONE - (30 MARKS)**

a) Define the following terms as used in electromagnetic theory.
   i. Magneto hydrodynamics (3 Marks)
   ii. Alfven's waves (3 Marks)

b) State the basic momentum and energy equations in MHD explaining each of the terms. (6 Marks)

c) An infinite insulated plate is set impulsively into motion with velocity v in its own plane in the presence of a transverse uniform magnetic field of strength $H_o$. Give a mathematical model of this flow. (6 Marks)

d) Compare and contrast between the magnetic Reynolds's number $(R\sigma)$ used in MHD and the ordinary Reynolds's number Re in hydrodynamics. (5 Marks)

e) Show that for a uniform flow along x – axis experiencing a shock (normal) along the y-axis and having a magnetic field parallel to the x-axis then $\frac{\rho_2}{\rho_1} = \frac{u_1}{u_2} = \frac{H_2}{H_1}$
$\rho, u$ *and* $H$ are the density, velocity and magnetic fields. (7 Marks)

**QUESTION TWO – (20 MARKS)**

a) State the Maxwells equations (4 Marks)

b) Show that the velocity distribution of a steady flow through an infinite annulus of radii $a$ *and* $b$ $(b > a)$ under a radial magnetic field is given by

$u = Ar^{M} + Br^{-M} + \frac{P}{\mu(M^2-4)}\ r^2$

where M is the Hartman number $M = \mu_e H_o a\sqrt{\frac{\sigma^1}{\mu}}$,

r is the radial distance from the axis of the annulus,

A and B are arbitrary constants. (16 Marks)

## QUESTION THREE – (2 MARKS)

Two plates are situated at $y^* = \pm 1$ and are at rest. An external magnetic field of constant strength $H_o$ is applied in the direction of y axis perpendicular to the flow direction. By taking the characteristic velocity as the velocity at the centre of the two plates, discuss the unsteady plane poiseuille flow and show that

$K + \nabla_1{}^2 v + \frac{R_h}{L}\frac{\partial v}{\partial y} = 0$ where $R_h = \mu_e H_o L\sqrt{\frac{\sigma}{\mu}}$, $\nabla_1{}^2 = \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ and

$v = u + H_x\sqrt{\nu_H}$ (20 Marks)

## QUESTION FOUR - (20 MARKS)

Formulate the two dimensional boundary layer equations over a flat plate having small electrical conductivity in the presence of constant transverse magnetic field.

(20 Marks)