TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF APPLIED AND HEALTH SCIENCES

MATHEMATICS AND PHYSICS

UNIVERSITY EXAMINATION FOR:

UNIT: CONTINUUM MECHANICS

UNIT CODE: AMA 4437

END OF SEMESTER EXAMINATION

SERIES: MAY SERIES

TIME: 2HOURS

Instructions to Candidates
You should have the following for this examination
-*Answer Booklet, examination pass and student ID*
This paper consists of five questions. Attempt Question one and any other two.
Do not write on the question paper.

Question ONE

a). Differentiate between Newtonian and Non-Newtonian fluid. (4mks)

b). Define the term:

i. Plasticity (2mks)

ii. Elasticity (2mks)

iii. Surface forces (Fs) (2mks)

c). Discuss the flow for which $w = z^2$ (5mks)

d). Prove that the contraction of the tensor A_q^p is a scalar or invariant. (5mks) e). In an incompressible flow the velocity vector is given by:

$V = (6xt + yz^2)i + (3t + xy^2)j + (xy - 2xyz - 6tz)k$

Verify whether the continuity equation is satisfied. (5mks)

f). Work the terms of the indicated sum

$$\overline{g_{rs}} = g_{jk} \frac{\partial x^i}{\partial x^{-r}} \frac{\partial x^k}{\partial x^{-s}}$$ N=3 (5mks)

Question TWO

a). If $\emptyset = A\,(x^2 - y^2)$ represent a possible flow phenomena. Determine the stream function. (4mks)

b). The velocity potential for 2-D flow is

$\emptyset = x(2y-1)$ at p(4,5). Determine

i. Velocity (4mks)

ii. Value of the stream function (4mks)

iii. Derive the continuity equation (8mks)

Question THREE

a). Determine the conjugate metric tensor in cylindrical co-ordinates (7mks)

b). Show that the contraction of the outer multiplication of the tensor A^p and B_q is an invariant. (6mks)

c). Solve the initial value problem (7mks)

$$\frac{d^2v}{dt^2} - \frac{2dv}{dt} - 8y = 0$$

y (0) = 3

$y^1(0) = 6$

Question FOUR

Let T be a second order tensor whose component in the Cartesian System (x_1, x_2, x_3) are given by:-

$$(T)_{ij} = T_{ij} = \text{T} = \begin{vmatrix} 3 & -1 & 0 \\ -1 & 3 & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

Given that the transformation matrix between the system is $(x_1, x_2, x_3) - (x_1^1, x_2^1, x_3^1)$ is

$$\text{A} = \begin{vmatrix} 0 & 0 & 1 \\ \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} & 0 \\ \frac{-\sqrt{2}}{2} & \frac{\sqrt{2}}{2} & 0 \end{vmatrix}$$

a) Obtain the tensor components T_{ij} in the now co-ordinate system (x_1^1, x_2^1, x_3^1) (7mks)

b) The stress state tensor at one point is represented by the carding stress tensor components.

$$\varphi_{ij} = \begin{vmatrix} 1 & a & b \\ a & 1 & c \\ b & c & 1 \end{vmatrix}$$

Where a, b and c are constants. Determine the constants a, b, c such that the traction vector on the octahedral is the null vector. (7mks)

c) The carding stress tensor component at the point of a Newtonian fluid, in which the bulk viscosity co-efficient is zero are given by:

$$\varphi_{ij} = \begin{vmatrix} -6 & 2 & -1 \\ 2 & -9 & 4 \\ -1 & 4 & -3 \end{vmatrix} P_a$$

Obtain the viscor's stress tensor component. (6mks)

Question FIVE

Under the restriction of small deformation theory the displacement field is given by

$$\bar{U} = \text{a}\,(x_1^2 - -5x_2^2)\,\hat{e_1} + (2ax_1x_2)\,\hat{e} - (0)\,\hat{e_3}$$

a) Obtain the linear strain tensor and linear spin tensor (10mks)

b) Given the shear modulus G obtain the value of the young modulus E to guarantee the balance at any point of the continuum. (10mks)