UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

FIRST SEMESTER EXAMINATIONS, NOV/DEC 2018

COURSE NO: MA 371
COURSE NAME: CONTIUUM MECHANICS
CLASS: MA III

TIME: 3 HOURS

Name**:** _____Index Number: _____

ANSWER ALL QUESTIONS.
All Questions Carry Equal Marks

Q1. (a) Explain the following terms:

i. Continuum Mechanics
ii. Configuration of continuum

(b). The stress matrix at a point *P* in a material is given as follows:

$$[\tau_{ij}] = \begin{bmatrix} 3 & 1 & 4 \\ 1 & 2 & -5 \\ 4 & -5 & 0 \end{bmatrix}$$

Determine:

i. the stress vector on the plane element *p* through *P* and parallel to the plane $2x_1 + x_2 - x_3 = 1$
ii. the magnitude of the stress vector
iii. the angle the stress vector makes with the normal

(c). Consider the following equation of motions:

$$x_1 = x_1^{\,0}, \quad x_2 = x_2^{\,0} + \frac{1}{2}tx_3^{\,0} \text{ and } x_3 = x_3^{\,0} + \frac{1}{2}tx_2^{\,0}$$

i. is this motion possible? Justify your answer
ii. obtain the velocity components in Lagrangian description

Q2. (a). Explain the difference between Lagrangian and Eulerian descriptions

(b). Consider the following equation of motions in Langragian description

$$x_1 = x_2^{\,0}t^2 + x_1^{\,0}, \quad x_2 = x_3^{\,0}t + x_2^{\,0} \text{ and } x_3 = x_3^{\,0}$$

Determine:

i. the displacement vector field in the Langrangian description at t = 2s
ii. the velocity components in Eulerian description
iii. the acceleration components in the Eulerian and Langragian description

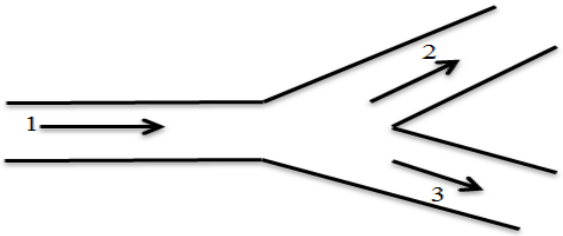
(c). With the aid of diagrams explain the following:

i. steady flow
ii. uniform flow
iii. lamina flow
iv. streamline

Q3. (a). Explain the difference between fluid and liquid

(b). A fluid is flowing through a cylindrical pipe with cross section area A at time *t* secs. If the mass flow rate of the fluid is *M* kg/s, the mean velocity is *V*m/s and the volume flow rate is *Q* m^3 /s. Show that $V = \frac{Q}{A}$. Hence or otherwise determine the mean velocity of the fluid if the cross-section area, A, is 1.2 x 10^{-3} m^2 and the discharge, Q is 24 *l/s*.

(c). Consider incompressible liquid flowing through the diagram below,



i. If pipe 1 diameter = 50 *mm*, mean velocity 2 *m/s*, pipe 2 diameter 40 *mm* takes 30% of total discharge and pipe 3 diameter 60 *mm*. Determine the values of discharge and mean velocity in each pipe.

ii. If the area in $A_1 = 8 \times 10^{-3}$ m^2, $A_1 = 3 \times 10^{-3}$ m^2 and $A_3 = 4 \times 10^{-3}$ m^2 and the upstream mean velocity, V_1 = 3.4 *m/s*. Calculate the downstream mean velocity V_3 if the other downstream mean velocity V_2 is 2.7 m/s.

Examiner: Dr L. Brew