

**M.Sc. MATHEMATICS**  
**THIRD SEMESTER**  
**CONTINUUM MECHANICS & HYDRODYNAMICS**  
**MSM-304**

Duration: 3 Hrs.

Marks: 70

PART : A (OBJECTIVE) = 20  
PART : B (DESCRIPTIVE) = 50

[ PART-B : Descriptive ]

Duration: 2 Hrs. 40 Mins.

Marks: 50

[ Answer question no. One (1) & any four (4) from the rest ]

1. Deduce Navier Stoke's equation. Prove Kelvin's circulation theorem. (5+5=10)
2. Explain viscous fluid and perfect fluid. Deduce Euler's equation of motion. (4+6=10)
3. Explain the Generalised Hooke's Law for isotropic elastic body. (10)
4. The stress tensor at a point is given by  $\sigma_{ij} = \begin{pmatrix} 0 & 1 & 2 \\ 1 & \sigma_{22} & 1 \\ 2 & 1 & 0 \end{pmatrix}$ . (5+5=10)  
Determine  $\sigma_{22}$  so that the stress vector on the same plane at the given point will be zero. Explain the stress quadric of Cauchy.
5. A displacement field is given by  $x_1 = X_1 + Ax_2$ ,  $x_2 = X_2 + Ax_3$ ,  $x_3 = X_3 + Ax_1$ . Calculate the Lagrangian linear strain tensor and Eulerian linear strain tensor. Compare them to the case when A is small. (5+5=10)
6. Explain the continuum concept. Deduce the relationship between stress vector and stress tensor. (4+6=10)
7. Explain the material and spatial methods of description of analysis of strain. Write about small deformation theory. (8+2=10)
8. Explain body force and surface force. Deduce Euler's equation of motion. (2+8=10)

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**[ PART-A : Objective ]**

Choose the correct answer from the following:

1×20=20

- Inertia force is an example of:
  - Surface force
  - Body force
  - Both of them
  - None of them
- A material having identical property at all points is \_\_\_\_ property.
  - Isophagus
  - Eulerian
  - Homogeneous
  - None of these
- A property which is directional at a point is known as \_\_\_\_\_.
  - Unhomogeneous
  - Anisophagus
  - Anisotropic
  - None of them
- In Continuum concept, the components perpendicular to the plane are:
  - Traction stresses
  - Unit stresses
  - Shear stresses
  - Normal stresses
- We define \_\_\_\_\_ as the possible pairs of traction vector and unit normal.
  - Cauchy stress
  - Stress principle
  - State of stress
  - All of these
- The equation  $|\sigma_{ij} - \delta_{ij}\sigma| = 0$  upon expansion gives a \_\_\_\_ polynomial.
  - Biquadratic
  - Quadratic
  - Quadric
  - Cubic
- The principal directions of Deviator Stress tensor are the same as those of \_\_\_\_\_.
  - Unit vector
  - Normal tensor
  - Stress vector
  - None of these
- The magnitude of normal stress component in quadric surface of Cauchy is \_\_\_\_\_ to  $r^2$ .
  - Inversely proportional.
  - Directly proportional.
  - Equal.
  - None of these.
- In the three equation of  $(\sigma_{ij} - \delta_{ij}\sigma)n_j = 0$ , there are \_\_\_\_\_ unknown.
  - Three
  - Five
  - Six
  - None of these
- Stress tensor is \_\_\_\_\_.
  - Equivalent
  - Asymmetric
  - Symmetric
  - None of these
- A necessary and sufficient condition for the inverse function to exist is Jacobian \_\_\_\_\_.
  - Vanishes.
  - Does not vanish.
  - Both of them.
  - None of them.
- $C_{ij} = \frac{\partial x_k}{\partial x_i} \frac{\partial x_k}{\partial x_j}$  is called the:
  - Undeformed tensor.
  - Green's deformation tensor.
  - Cauchy's deformation tensor.
  - All of these.
- $G_{ij} = \frac{\partial x_k}{\partial x_i} \frac{\partial x_k}{\partial x_j}$  is called the:
  - Undeformed tensor.
  - Green's deformation tensor.
  - Cauchy's deformation tensor.
  - All of these.



**UNIVERSITY OF SCIENCE & TECHNOLOGY, MEGHALAYA**



**[PART (A) : OBJECTIVE]**

Duration : 20 Minutes

Serial no. of the  
main Answer sheet

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14.  $\frac{1}{2} \left( \frac{\partial x_k}{\partial x_i} \frac{\partial x_k}{\partial x_j} - \delta_{ij} \right)$  is equal to:

- a.  $\delta_{ij}$
- b.  $L_{ij}$
- c.  $E_{ij}$
- d. All of these

15.  $\frac{1}{2} \left( \delta_{ij} - \frac{\partial x_k}{\partial x_i} \frac{\partial x_k}{\partial x_j} \right)$  is equal to:

- a.  $\delta_{ij}$
- b.  $L_{ij}$
- c.  $E_{ij}$
- d. All of these

16. For small deformation theory we have

- a.  $l_{ij} = C_{ij}$
- b.  $l_{ij} = e_{ij}$
- c.  $l_{ij} \neq e_{ij}$
- d.  $l_{ij} \neq C_{ij}$

17. A homogeneous material is one having \_\_\_\_\_ proposition in all directions.

- a. Dissimilar
- b. Unidentical
- c. Identical
- d. None of these

18. For incompressible flow, with fluid velocity  $q$ , the equation of continuity is:

- a. Curl.  $q$  is zero.
- b. Grad  $q$  is zero.
- c. Div  $q$  is zero.
- d. None of these.

19. From the law of conservation of mass, the mass contained inside a given volume of fluid remains \_\_\_\_\_ throughout the motion.

- a. Changing.
- b. Unchanged.
- c. Changes time to time.
- d. None of these.

20. A fluid motion in which the flow pattern remains unchanged with time is said to be:

- a. Unsteady
- b. Steady
- c. Laminar
- d. Turbulent

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Course : .....

Semester : ..... Roll No : .....

Enrollment No : ..... Course code : .....

Course Title : .....

Session : ..... 2017-18 ..... Date : .....

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**Instructions / Guidelines**

- The paper contains twenty (20) / ten (10) questions.
- Students shall tick (✓) the correct answer.
- No marks shall be given for overwrite / erasing.
- Students have to submit the Objective Part (Part-A) to the invigilator just after completion of the allotted time from the starting of examination.

Full Marks	Marks Obtained
20	

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Scrutinizer's Signature

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Examiner's Signature

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Invigilator's Signature