Write the following information in the first page of Answer Script before starting answer

ODD SEMESTER EXAMINATION: 2020-21

Exam ID Number_____

Course_____ Semester_____

Paper Code _____Paper Title _____

Type of Exam: _____ (Regular/Back/Improvement)

Important Instruction for students:

1. Student should write objective and descriptive answer on plain white paper.
2. Give page number in each page starting from 1st page.
3. After completion of examination, Scan all pages, convert into a single PDF, rename the file with Class Roll No. **(2019MBA15)** and upload to the Google classroom as attachment.
4. Exam timing from 10am – 1pm (for morning shift).
5. Question Paper will be uploaded before 10 mins from the schedule time.
6. Additional 20 mins time will be given for scanning and uploading the single PDF file.
7. Student will be marked as ABSENT if failed to upload the PDF answer script due to any reason.

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

Duration : 3 hrs. **Full Marks : 70**

(PART-A : Objective)

Time : 20 min. **Marks : 20**

Choose the correct answer from the following: ***1X20=20***

1. In equation of continuity, _____is conserved.
a. Energy **b.** Temperature
c. Mass **d.** None of these

2. In equation of motion, _____is conserved.
a. Velocity **b.** Stress tensor
c. Mass **d.** Energy

3. Inertia force is an example of:
a. Surface force **b.** Body force
c. Both of these **d.** None of these

4. A material having identical property at all points is _____property.
a. Isophagus **b.** Homogeneous
c. Eulerian **d.** None of these

5. A property which is directional at a point is known as_____.
a. Unhomogeneous **b.** Anisotropic
c. Anisophagus **d.** None of these

6. In Continuum concept, the components perpendicular to the plane are_____.
a. Traction stresses **b.** Shear stresses
c. Unit stresses **d.** None of this

7. We define _____as the possible pairs of traction vector and unit normal.
a. Normal stress **b.** State of stress
c. Stress principle **d.** None of these

8. The magnitude of normal stress component in quadric surface of Cauchy is _____to r^2.
a. Inversely proportional **b.** Equal
c. Directly proportional **d.** None

9. In the three equation of $(\sigma_{ij} - \delta_{ij}\sigma)n_j = 0$, there are _____unknown.
a. Three **b.** Six
c. Five **d.** None of these

10. A necessary and sufficient condition for the inverse function to exist is Jacobian _____.
a. Vanishes **b.** Does not vanish
c. Both of them **d.** None of them

11. Stress tensor is_____.

a. Equivalent
b. Asymmetric
c. Symmetric
d. None of these

12. $C_{ij} = \frac{\partial x_k}{\partial x_i}\frac{\partial x_k}{\partial x_j}$ is called the:

a. Undeformed tensor
b. Green's deformation tensor
c. Cauchy's deformation tensor
d. None of these

13. $G_{ij} = \frac{\partial x_k}{\partial X_i}\frac{\partial x_k}{\partial X_j}$ is called the:

a. Undeformed tensor
b. Green's deformation tensor
c. Cauchy's deformation tensor
d. None of these

14. A divergence of a vector f is written as:

a. ∇f
b. $\nabla . f$
c. $\nabla \times f$
d. None 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. δ_{ij}
b. E_{ij}
c. L_{ij}
d. None of these

16. A gradient of a vector f is written as:

a. ∇f
b. $\nabla . f$
c. $\nabla \times f$
d. None of these

17. For small deformation theory we have:

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

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

a. Curl. q is zero
b. Div. q is zero
c. Grad q is zero
d. 1

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

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

20. A flow where the particles move parallel to each other is known as:

a. Laminar
b. Turbulent
c. None of these
d. All of these

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PART-B : Descriptive

Time : 2 hrs. 40 min. **Marks : 50**

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

1. The stress tensor at a point is given by $\sigma_{ij} = \begin{pmatrix} 0 & 1 & 2 \\ 1 & \sigma_{22} & 1 \\ 2 & 1 & 0 \end{pmatrix}$. Determine σ_{22} so that the stress vector on the same plane at the given point will be zero. Explain the stress quadric of Cauchy. 5+5=10

2. 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

3. Explain the continuum concept. Deduce the relationship between stress vector and stress tensor. 5+5=10

4. Explain the material and spatial methods of description of analysis of strain. Write about small deformation theory. 5+5=10

5. At a point in an incompressible fluid having spherical polar coordinates (r,θ, φ), the velocity components are given by $2Mr^{-3}cos\theta,\ Mr^{-3}sin\theta, 0$, where M is a constant. Show that the motion is irrotational. Also, find the equation of streamlines. 5+5=10

6. If the lines of motion are curves on the surfaces of cones having the vertices at the origin and the axis of Z for common surface, prove that the equation of continuity is $\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u)}{\partial r} + \frac{2\rho u}{r} + \frac{cosec\ \theta}{r}\frac{\partial (\rho w)}{\partial \varphi} = 0$ where u and w are the velocity components along the increasing direction of r and φ. 10

7. Describe the methods to describe fluid motion. Deduce the differential equation of streamlines. 5+5=10

8. Explain Stretch Ratio. Determine the shear angle γ_{23} for the simple shear displacement 2+8=10

$$x_1 = X_1, x_2 = X_2, x_3 = X_3 + \frac{2X_2}{\sqrt{3}}$$

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