

X

NPTEL

reviewer1@nptel.iitm.ac.in ▼

Courses » **Mechanics Of Materials** Announcements **Course** Ask a Question Progress Mentor

# Unit 7 - Week 5-Constitutive relation, strain energy and potential

## Course outline

### Week 0

### How to access the portal

### Week 1

### Week 2

### Week 3

### Week 4-Concept of strain

### Week 5- Constitutive relation, strain energy and potential

- Transformation of strain components/ Strain Rosette
- Compatibility condition
- Constitutive relation
- Young's Modulus and Poisson's Ratio
- Shear Modulus
- Bulk Modulus
- Restriction on material parameters
- Thermal strain
- Strain energy, load potential and total potential
- Quiz : Assignment 5

## Assignment 5

The due date for submitting this assignment has passed. **Due on 2018-02-28, 23:59 IST.**

### Submitted assignment

Based on the data given in the question 1, answer the following up to question 13

1)

A body in the form of a cube,  $B = \{(X, Y, Z) | -1\text{cm} \leq X \leq 1\text{cm}, -1\text{cm} \leq Y \leq 1\text{cm}, -1\text{cm} \leq Z \leq 1\text{cm}\}$  in the reference configuration, is subjected to the following displacement field:

$$u_x = 0, u_y = (Y+Z)10^{-4}, u_z = 10^{-4}Z,$$

where,  $(X, Y, Z)$  are the Cartesian coordinates of a material point before deformation. Both the reference and current configuration is described using the same coordinate system with basis  $\{e_x, e_y, e_z\}$ . Assuming that the cube is made of a material whose constitutive relation is given by isotropic Hooke's law:  $\sigma = \lambda \text{tr}(\epsilon) \mathbf{1} + 2\mu \epsilon$ , with  $\lambda = 115 \text{ GPa}$  and  $\mu = 77 \text{ GPa}$ . For the specified displacement field compute the following accurately up to first decimal place:

The  $\epsilon_{yy}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-4}$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

(Type: Numeric) 1

3 points

2) The  $\epsilon_{yz}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-4}$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

(Type: Numeric) 0.5

3 points

3) The  $\epsilon_{zz}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-4}$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

- Week 5  
Feedback
- Solution for  
Assignment - 5

Week 6-  
Displacement  
due to uniaxial  
loading,  
temperature and  
bending

Week 7 -Stresses  
and deflection in  
homogeneous  
beams loaded  
about one  
principal axis

Week 8 -  
Stresses and  
deflection in  
beams loaded  
about one  
principal axis

week 9: Stresses  
and deflection in  
beams not  
loaded about  
principal axis

Week 10:  
Stresses and  
displacement  
due to torsion or  
inflation

Week 11

Week 12 -  
Buckling of  
columns

DOWNLOAD  
VIDEOS

Notes

(Type: Numeric) 1

3 points

4) The  $\sigma_{xx}$  component of the stress tensor is: \_\_\_\_\_ MPa

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
(Type: Range) 23.0,23.2

3 points

5) The  $\sigma_{yy}$  component of the stress tensor is: \_\_\_\_\_ MPa

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
(Type: Range) 38.4,38.6

3 points

6) The  $\sigma_{yz}$  component of the stress tensor is: \_\_\_\_\_ MPa

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
(Type: Range) 7.6,7.8

3 points

7) The  $\sigma_{zz}$  component of the stress tensor is: \_\_\_\_\_ MPa

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
(Type: Range) 38.4,38.6

3 points

8) The maximum normal stress in the cube is: \_\_\_\_\_ MPa

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
(Type: Range) 46.0,46.2

3 points

9) The minimum normal stress in the cube is: \_\_\_\_\_ MPa

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
(Type: Range) 23.0,23.2

3 points

10 The maximum shear stress in the cube is: \_\_\_\_\_ MPa

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 11.4,11.6

3 points

11) Is the state of strain plane?

3 points

- Yes  
 No

No, the answer is incorrect.

Score: 0

Accepted Answers:

Yes

12) Is the state of stress plane?

3 points

- Yes  
 No

No, the answer is incorrect.

Score: 0

Accepted Answers:

No

13)

3 points

If the direction along which the maximum normal strain occurs is  $n_\epsilon$  and the normal to the plane on which the maximum normal stress occurs is  $n_\sigma$  then which of the following is correct:

- $n_\sigma - n_\epsilon = 0$   
  $n_\sigma \cdot n_\epsilon = 0$   
  $n_\sigma + n_\epsilon = 0$   
  $n_\sigma \wedge n_\epsilon = 0$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$n_\sigma - n_\epsilon = 0$

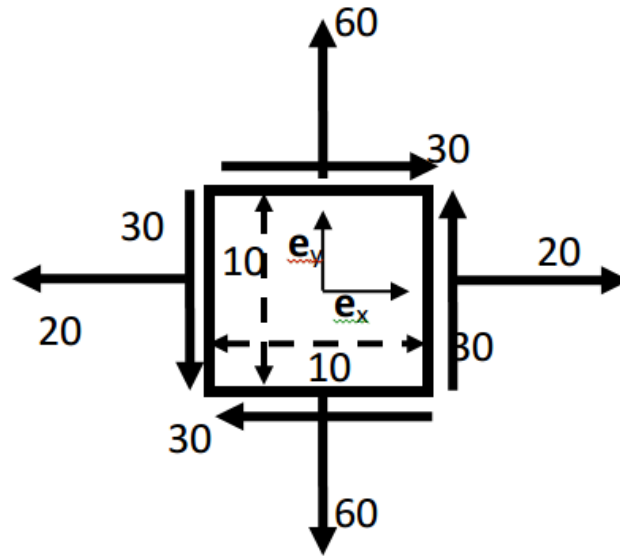
Based on the data given in question 14, answer the following up to question 25

14)

A square plate of side 10 cm and thickness 1 cm is subjected to the following state of plane

stress,  $\sigma = \begin{pmatrix} 20 & 30 & 0 \\ 30 & 60 & 0 \\ 0 & 0 & 0 \end{pmatrix}$  MPa with the non-zero components of the stress acting along

the sides of the plate as shown in the figure. Assume that the plate is made of steel which obeys isotropic Hooke's law with Young's modulus,  $E = 200$  GPa and Poisson's ratio,  $\nu = 0.3$ . For this state of stress compute the following accurately up to the second decimal place



The  $\epsilon_{xx}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 10

3 points

15 The  $\epsilon_{yy}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 270

3 points

16 The  $\epsilon_{xy}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 195

3 points

17 The  $\epsilon_{zz}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) -120

3 points

18)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 16

3 points

19 The change in thickness of the plate is: \_\_\_\_\_  $\times 10^{-3}$  mm

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) -1.2

3 points

20 The maximum normal strain is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 373,375

3 points

21 The maximum shear strain is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 246,248

3 points

22 The minimum normal stress is: \_\_\_\_\_ MPa

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 0

3 points

23) Is the state of strain plane?

3 points

Yes

No

No, the answer is incorrect.

Score: 0

Accepted Answers:

No

24) Is the state of stress plane?

3 points

Yes

No

No, the answer is incorrect.

Score: 0

Accepted Answers:

Yes

25)

3 points

- $\mathbf{n}_\sigma - \mathbf{n}_\epsilon = 0$   
  $\mathbf{n}_\sigma \cdot \mathbf{n}_\epsilon = 0$   
  $\mathbf{n}_\sigma + \mathbf{n}_\epsilon = 0$   
  $\mathbf{n}_\sigma \wedge \mathbf{n}_\epsilon = 0$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\mathbf{n}_\sigma - \mathbf{n}_\epsilon = 0$$

26)

3 points

Three experimentalists report the following matrix components for the strain tensor at a given

point in the body subjected to the same loading:  $\boldsymbol{\epsilon}_1 = \begin{pmatrix} 1.1 & 0.1 & 0 \\ 0.1 & -0.9 & 0 \\ 0 & 0 & 0 \end{pmatrix} \times 10^{-4}$ ,

$$\boldsymbol{\epsilon}_2 = \begin{pmatrix} 1.105 & 0 & 0 \\ 0 & -0.905 & 0 \\ 0 & 0 & 0 \end{pmatrix} \times 10^{-4}, \quad \boldsymbol{\epsilon}_3 = \begin{pmatrix} 1.11 & 0.12 & 0 \\ 0.12 & -0.85 & 0 \\ 0 & 0 & 0 \end{pmatrix} \times 10^{-4}$$

Which of the two experimentalist have the equivalent representation of the strain?

- $\epsilon_1$  and  $\epsilon_2$   
  $\epsilon_1$  and  $\epsilon_3$   
  $\epsilon_2$  and  $\epsilon_3$   
 None of them represent the same strain

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\epsilon_1$  and  $\epsilon_2$

Based on the data given in the question 27, answer the following up to question 29

27 A 60 degree strain rosette is used to infer the components of the strain on the surface of a plate, as shown in the figure. If the reading of the three strain gauges as indicated in the figure is,  $\epsilon_1 = 100 \times 10^{-6}$ ,  $\epsilon_2 = 200 \times 10^{-6}$ ,  $\epsilon_3 = 300 \times 10^{-6}$ , find the following accurately up to the first decimal place

The  $\epsilon_{xx}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 99,101

4 points

28 The  $\epsilon_{yy}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 299,301

4 points

29 The  $\epsilon_{xy}$  component of the linearized strain tensor is: \_\_\_\_\_  $\times 10^{-6}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) -57.8,-57.6

4 points

Indicate if the following strains are possible in a body:

30

i. 
$$\epsilon = \begin{pmatrix} x^2 + y^2 & xy & 0 \\ xy & y^2 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

5 points

Yes

No

No, the answer is incorrect.

Score: 0

Accepted Answers:

Yes

31

ii. 
$$\epsilon = \begin{pmatrix} x^2 - y^2 & \sin(y) & 0 \\ \sin(y) & x^2 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

5 points

Yes

No

No, the answer is incorrect.

Score: 0

Accepted Answers:

Yes

Previous Page

End



Funded by

Government of India  
Ministry of Human Resource Development

Powered by

