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5E3175

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B.Tech. V Sem.(Main/Back) Exam Dec. 2012

Mechanical Engg.

5ME1 Advanced Mechanics of Solids

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 24

Instructions to Candidates:

*Attempt any **five question** selecting **one question** from each unit . All Questions carry equal marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used / calculated must be stated clearly.*

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. ______Nil______ 2. ______Nil______

UNIT-I

Q.1 (a) Define state of stress at a point. (3)

(b) Derive expression for stress component on an arbitrary plane in terms of rectangular stress components. (5)

(c) The state of stress at a point is characterised by the matrix shown. Determine T_{22} such that there is at least one plane passing through the point in such a way that the result ant stress on that plane is zero. Determine the direction cosines of the normal to that plane. (4+4)

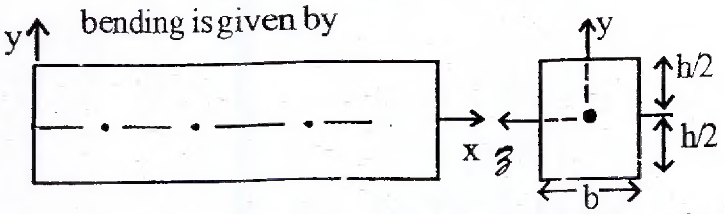
$$[Tij] = \begin{bmatrix} 0 & 2 & 1 \\ 2 & T_{22} & 2 \\ 1 & 2 & 0 \end{bmatrix}$$

OR

Q.1 (a) Explain the terms (i) pure shear stress (ii) stress invariants and its property (2+3)

(b) Explain Mohr's circle diagram for 3 dimensional state of stress indicating Mogr's stress plane π. (3)

(c) Consider the rectangular beam shown below. According to the elementary theory of bending the " fibre stress" in the elastic range due to bending is given by



$\sigma_x = -\frac{My}{I} = -\frac{12My}{bh^3}$

where M is bending moment which is a function of x. Assume that $\sigma_z = \tau_{zx} = \tau_{zy} = 0$ and also that $\tau_{xy} = 0$ at the and bottom and further that $\sigma_z = 0$ at the bottom. Using differential equations of equilibrium, detemine τ_{xy} and σ_y. (4+4)

UNIT-II

Q.2 (a) The rectangular components of a small strain at a point is given by the following matrix. Determine the principal strains and the direction of the maximum unit strain (i.e. εmax) (6+4)

$$[\varepsilon ij] = p \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & -4 \\ 0 & -4 & 3 \end{bmatrix} \quad \text{where } p = 10^{-4}$$

$\varepsilon xx = a + b(x^2+y^2) + x^3 + y^3$, $\gamma yz = 0$

$\varepsilon yy = \alpha + \beta(x^2+y^2) + x^3 + y^3$, $\gamma zx = 0$

$\gamma xz = A + B\, xy(x+y-c)$. $\varepsilon zz = 0$ (6)

OR

Q.2 (a) If the displacement field is fiven by

$Ux = Kxy,\ Uy = Kxy,\ Uz = 3K(x+y)z$

where K is a constant small enough to ensure applicability of the small deformation theory,

(i) write down the strain matrix

(ii) what is the strain in the direction $n_x = n_y = n_z = 1/\sqrt{3}$? (5+3)

(b) The displacement field for a body is given by
$U = K'(x^2+y)\, i + K'(y+z)\, j + K'(x^2+2z^2)\, K$

where $K' = 10^{-3}$. At a point p(2,2,3), consider two line segments PQ and QR having the following direction cosines before deformation

PQ: $n_{x1} = n_{y1} = n_{z1} = 1/\sqrt{3}$ PR: $n_{x2} = n_{y2} = 1/\sqrt{2}$, $n_{z2} = 0$

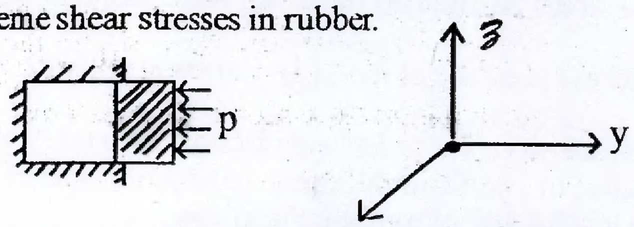
Determine the angle between the two segments before and after deformation. (2+6)

UNIT-III

Q.3. (a) A rubber cube is inserted in a cavity of same form and size in a steel block and from right hand open side it is pressed by a steel block with a presure of P pascals as shown in the figure. Taking axes as shown in its figure and considering steel is be absolutely hard and no friction exists between steel & rubber,find.

(i) The pressure of rubber against the box walls, and

(ii) The extreme shear stresses in rubber. (4+4)



(b) Derive displacement equations of equilibrium for an isotropic material. (8)

OR

Q.3 (a) Define isotropic , anisotropic and orthotropic materials giving two examples of each type. (8)

(b) For the given strain matrix at a point , determine the stress matrix. Take $E = 207 \times 10^6$ kPa and $G = 80 \times 10^6$ kPa for the steel material. (8)

$$[\varepsilon_{ij}] = \begin{bmatrix} 0.001 & 0 & -0.002 \\ 0 & -0.003 & 0.0004 \\ -0.002 & 0.0004 & 0 \end{bmatrix}$$

UNIT-IV

Q.4 (a) Derive winkler - Bach formula to find bending stresses in initially curred beams. (8)

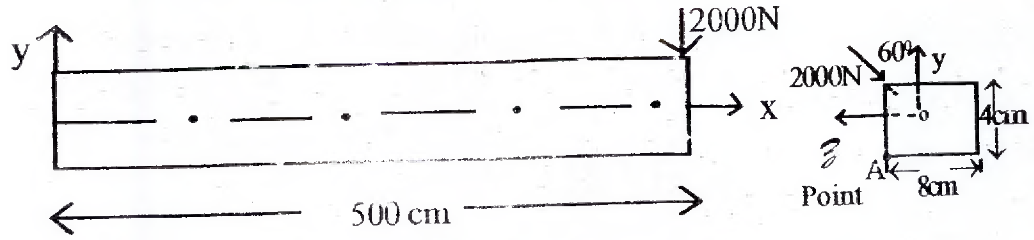
(b) A curved bar of square section 3 cm sides, mean radius of curvature 4.5 cm is initially unstressed. If a bending moment of 300 N-cm is applied to bar to straighten it find the stresses at inner and outer faces and draw the stress profile across the section. (6+2)

OR

Q.4 (a) Define shear centre. Explain difference between symmetrical and unsymmetrical bending. (2+3)

(b) Indicate the flow of distribution of shear stress due to transverse shear and shear centre location for a thin walled inverted T section (3)

(c) A cantilever beam of rectangular section is subjected to a load of 2000 N which is inclined at an angle of 60° to the vertical as shown in figure below. Determine the stress due to bending at point A near the built in end ? (8)



UNIT-V

Q.5. (a) What is a composite tube? How is it formed? What advantage does it offer? (1+1+2)

(b) Draw the stress profile for σ_r & σ_θ for the thick cylinder subjected to

(i) Internal pressure alone (ii) External pressure alone (2+2)

(c) Derive expressions for radial and circum ferential stresses induced in a rotating disc of uniform thickness. Also find value of σ_r and σ_θ in duced in a solid disc of uniform thickness. (6+2)

OR

Q.5 (a) A flat steel disk of 150 cm diameter with a 30 cm diameter hole is shrunk around a solid steel shaft. The shrink - fit allowance is 1 part in 1000 (i.e.an allowance of 0.0150 cm in radium). E = 2.18×10^6 kg f/cm². As sume that equations as for solid disk are applicable to rotating solid shaft also.
Take ν =0.3 for steel . and ρ =8.1 gm/ cm³

(i) What are stresses due shrink - fit ?

(ii) At what rpm will the shrink fit loosen up as a result of rotation ? (4+6)

(b) A thick - walled steel cylinder with radii a =5 cm and b=10cm is subjected to an internal pressure P. The yield stress in tension for the material is 350 mpa. Using a FOS of 1.5, determine the maximum working pressure P according to (i) Maximum Normal stress theory (ii) Maximum Shear stress theory (3+3)

(Take allowable shear stress as 0.5 times allowable tenstile stress in the material).
