APL 104: Quiz 2 (Set A)

Full Marks: ~~22~~ 26 Duration: 1 hrs Date: 2nd Nov 2016

Problem 1: A body undergoes deformation as follows:

$$u_x = ay,\ u_y = 0,\ u_z = 0.$$

This is also called simple shearing of a body. Here a is a constant denoting the amount of shear. How much is the volumetric strain generated during the deformation?
(a) 0 (b) can't say (c) a (d) 3a (2)

Problem 2: Assuming the body were isotropic, which component of stress would be non-zero for problem 1?
(a) σ_{xx} (b) τ_{xy} (c) τ_{yz} (d) none of these (2)

Problem 3: What is the value of maximum principal stress for Problem 1?
(a) 0 (b) can't say (c) G a (d) None of these (2)

Problem 4: A beam has arbitrarily shaped crosss-section but its moment of area are as follows: $I_{yy} = I_{zz}, I_{yz} = 0$. Suppose it is subjected to distributed load in 'y' direction (see Fig.4 in the back). In which plane will the beam bend? Y-Z are automatically principal directions
(a) x-y plane (b) x-z plane
(c) neither (a) nor (b) (d) a plane mid-way between (x-y) and (x-z) plane (2)

Problem 5: For the cross-section shown in Fig.5, what could be the most suitable location of shear center?
(a) A (b) B (c) C (d) ~~none~~ D (2)

shear centre lies on line of symmetry. For this case, it also has to lie outside the ring!

Problem 6: When a aluminium hollow tube is shrunk fit with a aluminium solid tube whose outer radius is larger than inner radius of hollow tube, there could be a jump at the interface of two tubes in
(a) σ_{rr} (b) $\sigma_{\theta\theta}$ (c) $\sigma_{r\theta}$ (d) no jump can occur. (2)

Problem 7: A hollow shaft is rotating at constant angular speed but it is subjected to no internal or external pressure, the following component of stress vanishes throughout the tube:
(a) σ_{rr} (b) $\sigma_{\theta\theta}$ (c) both (a) and (b) (d) none of these (2)

Problem 8: A beam is clamped at one end while pinned at the other end as shown in Fig.8. What boundary conditions are needed to obtain deflection using Timoshenko's beam theory?
(a) $y(0) = 0, \theta(0) = 0, \text{moment}(L) = 0$ (b) $y(0) = 0, \theta(0) = 0, y(L) = 0, \text{moment}(L) = 0$
(c) $y(0) = 0, y'(0) = 0, y(L) = 0, \text{moment}(L) = 0$ (d) none of these (2)

Problem 9: A beam is subjected to boundary condition as shown in Fig.9. Its deflection cannot be determined using the Timoshenko's beam theory that we learnt in the class because:
(a) can be determined (b) there are four boundary conditions but five unknowns

4 BC's:- $y(0)=0,\ \theta(0)=0,\ y(L)=0,\ \theta(L)=0$

5 Unknowns:- $M(L)$, two reaction forces at (L), two integrating constants of beam equations.

both horizontal & vertical reactions

(c) there are 3 boundary conditions but four unknowns (d) none of these (2)

Problem 10: The buckling load obtained using Timoshenko's and Euler-Bernouli beam theory will be:
(a) same because the actual beam is same in both the cases (b) different
(c) can't say (d) none of these (2)

Problem 11: Think of solving deflection of a column (see Fig.11) based on Euler Bernouli theory. The bending moment will vary according to:
(a) m(x) = P(y(L)-y(x)) (b) m(x) = -P y(x) (c) m(x) = 0 (d) m(x) = P (2)

Problem 12: The buckling load obtained for problem 11 would be:
(a) $\frac{\pi^2 EI}{4L^2}$ (b) $\frac{\pi^2 EI}{L^2}$ (c) $\frac{4\pi^2 EI}{L^2}$ (d) none of these (see below for solution) (4)

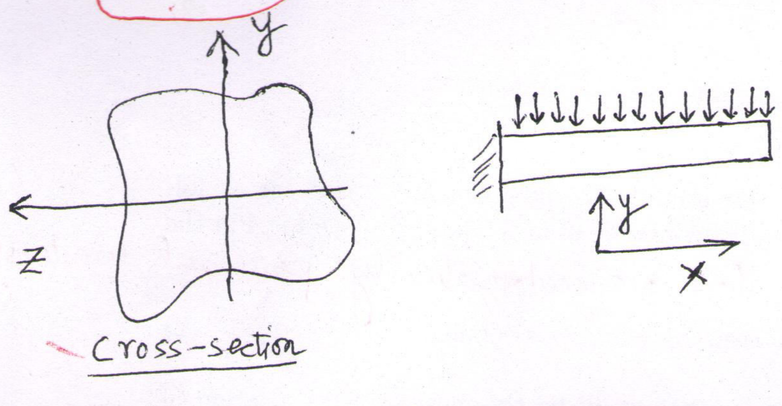


Fig.4

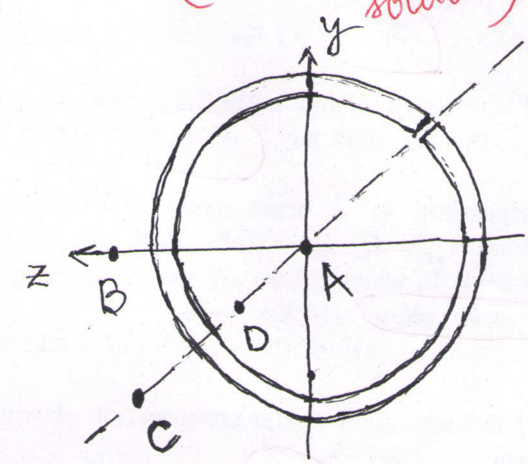


Fig 5: Circular ring (with a cut)

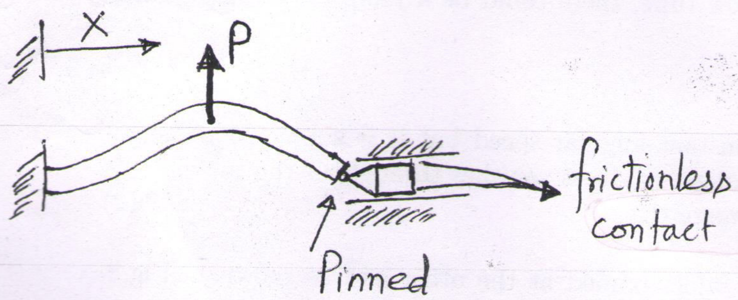


Fig. 8

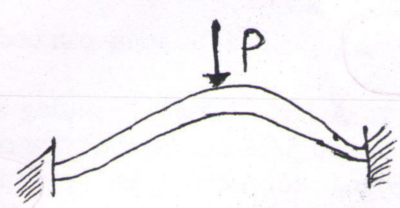
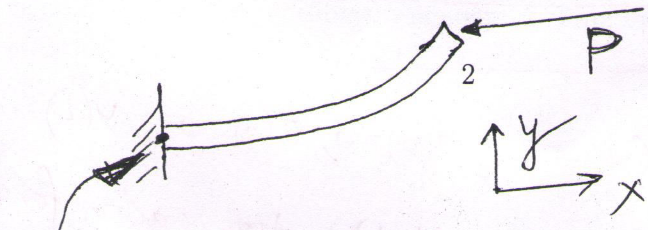


Fig.9



Origin

Fig.11

Problem 12

Eq:- $EI\frac{d^2y}{dx^2} + Py(x) - Py(L) =$

Solution,

Particular integral, $y(x) = y(L)$

General solution

$y(x) = C_1\cos(\omega x) + C_2\sin(\omega x) + y(L)$

$\omega^2 = \frac{P}{EI}$

Boundary condition:- $y(0) = 0$, $\frac{dy}{dx}(0) = 0$

$C_1 = -y(L)$, $\cos(\omega L) = 0$

$\cos(\omega L) = 0$
$\Rightarrow \omega L = \pi/2 \Rightarrow P = \frac{\pi^2 EI}{4L^2}$