DEPARTMENT OF CIVIL ENGINEERING

CE-221 SOLID MECHANICS

Quiz-1 20/08/16 PAPER CODE: A

Note: Write your name & roll no. on answerbook and on summary answer sheet provided on the reverse.
You must submit the question-paper-cum-summary-answer-sheet along with the answerbook.
Closed book, closed notes test. No formula sheet allowed. No mobile phones allowed in the exam hall.
Both questions carry equal marks. Assume suitable data if required and state the same clearly

Problem 1

Calculate the shear stress in bolts *A* and *C* caused by the applied load shown in **Fig. 1**.
The bolt ***A*** is **6 mm** in diameter and acts in single shear. The bolt ***C*** is **8 mm** in diameter and acts in double shear. All dimensions are in mm.

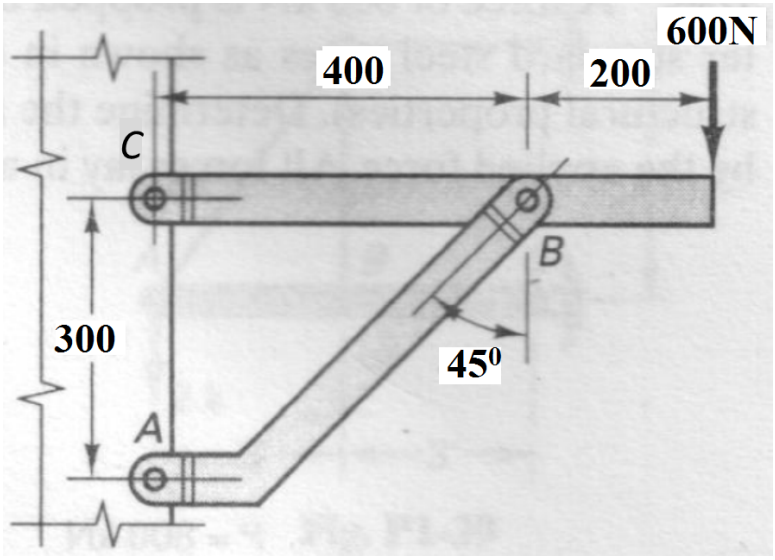

Fig. 1

Problem 2

The truss ***ABC*** shown in **Fig. 2** supports a force ***P*** at joint ***B*** that acts at an angle θ to the vertical. $0^0 \le \theta \le 90^0$ and θ is positive as shown. The cross-sectional areas and moduli of elasticity of members ***AB*** and ***BC*** are the same.

Find θ so that the deflection of the joint *B* will be in the same direction as the force *P*.

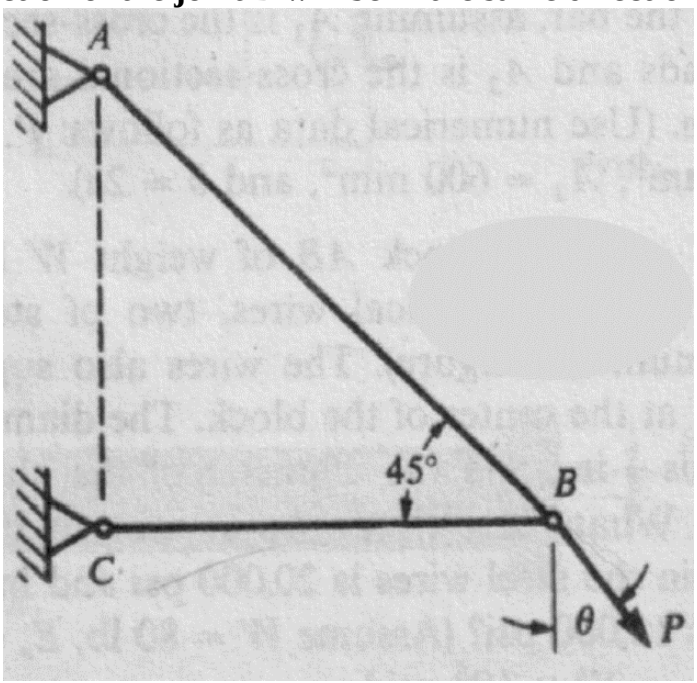

Fig. 2

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CE-221 SOLID MECHANICS

Quiz-1 20/08/16 PAPER CODE: B

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Problem 1

Calculate the shear stress in bolts *A* and *C* caused by the applied load shown in **Fig. 1**.
The bolt ***A*** is **8 mm** in diameter and acts in double shear. The bolt ***C*** is **6 mm** in diameter and acts in single shear. All dimensions are in mm.

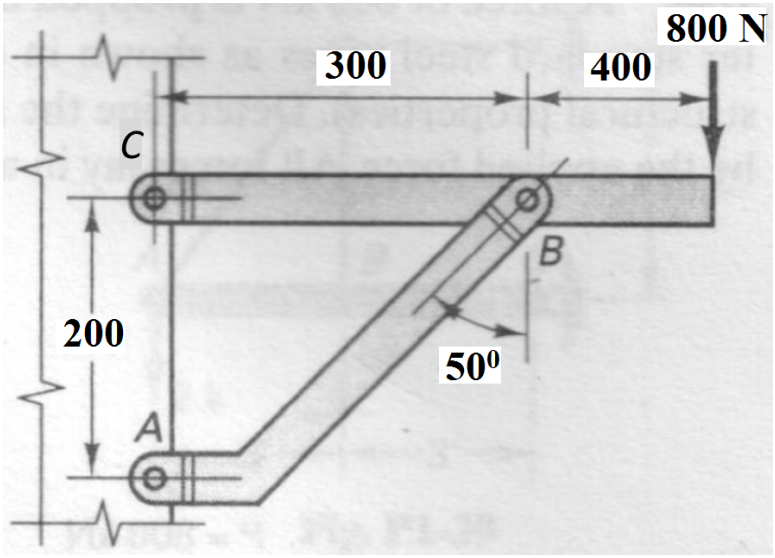

Fig. 1

Problem 2

The truss ***ABC*** shown in **Fig. 2** supports a force ***P*** at joint ***B*** that acts at an angle θ to the vertical. $0^0 \le \theta \le 90^0$ and θ is positive as shown. The cross-sectional areas and moduli of elasticity of members ***AB*** and ***BC*** are the same.

Find θ so that the deflection of the joint *B* will be in the same direction as the force *P*.

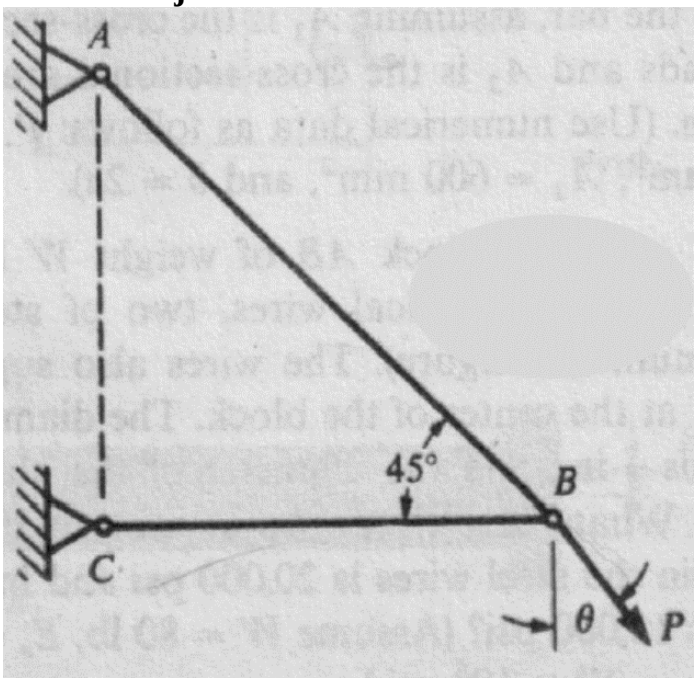

Fig. 2

DEPARTMENT OF CIVIL ENGINEERING

CE-221 SOLID MECHANICS

Quiz-1 20/08/16 PAPER CODE: C

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Problem 1

Calculate the shear stress in bolts *A* and *C* caused by the applied load shown in **Fig. 1**.
The bolt ***A*** is **10 mm** in diameter and acts in single shear. The bolt ***C*** is **5 mm** in diameter and acts in double shear. All dimensions are in mm.

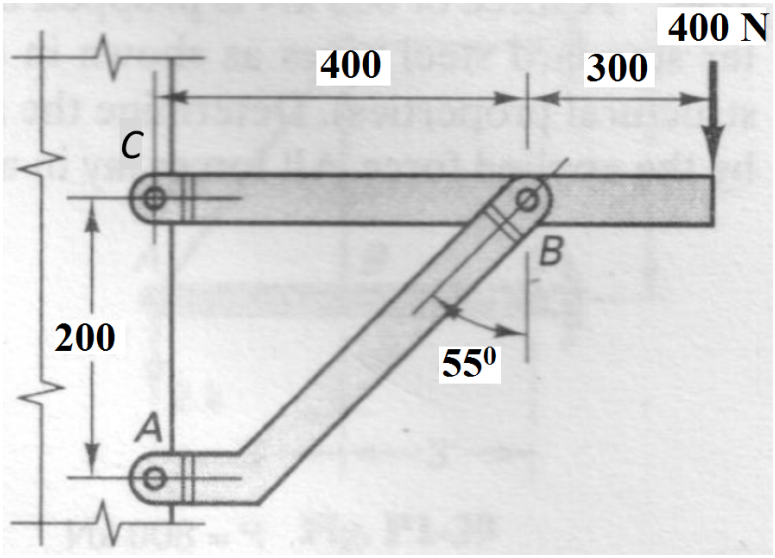

Fig. 1

Problem 2

The truss ***ABC*** shown in **Fig. 2** supports a force ***P*** at joint ***B*** that acts at an angle θ to the vertical. $0^0 \le \theta \le 90^0$ and θ is positive as shown. The cross-sectional areas and moduli of elasticity of members ***AB*** and ***BC*** are the same.

Find θ so that the deflection of the joint *B* will be in the same direction as the force *P*.

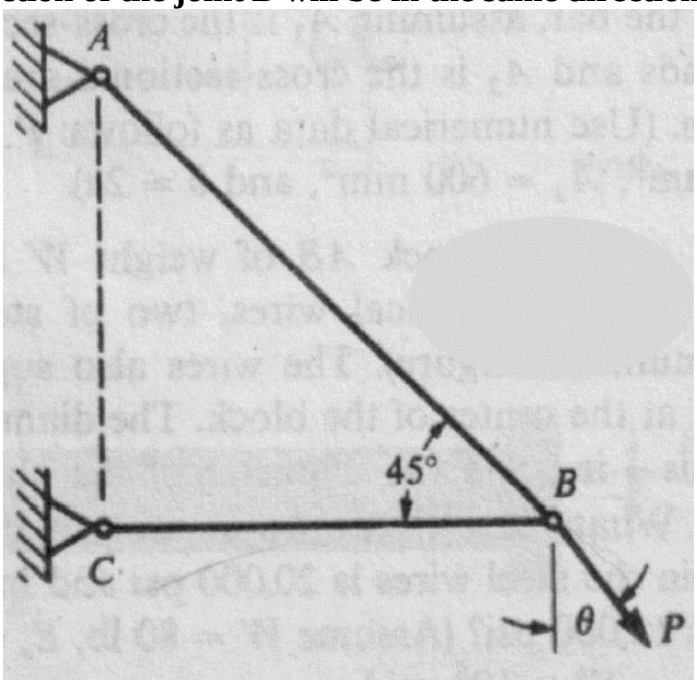

Fig. 2

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CE-221 SOLID MECHANICS

Quiz-1 20/08/16 PAPER CODE: D

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Both questions carry equal marks. Assume suitable data if required and state the same clearly

Problem 1

Calculate the shear stress in bolts *A* and *C* caused by the applied load shown in **Fig. 1**.
The bolt ***A*** is **5 mm** in diameter and acts in double shear. The bolt ***C*** is **10 mm** in diameter and acts in single shear. All dimensions are in mm.

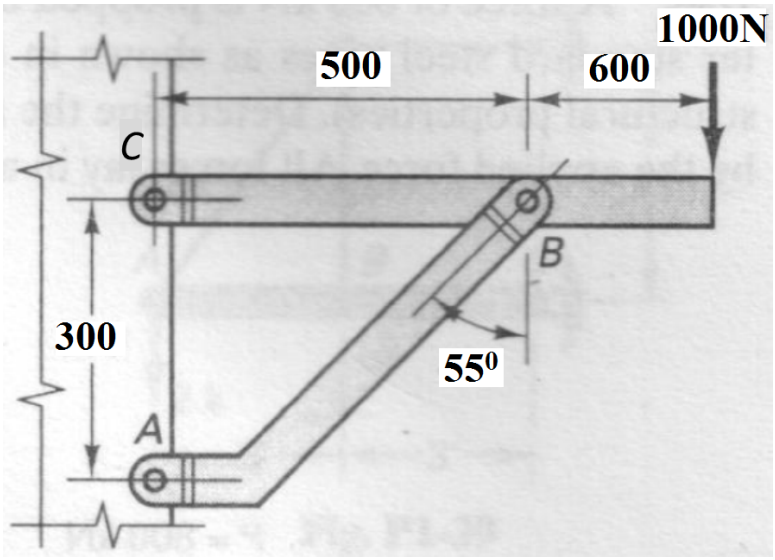

Fig. 1

Problem 2

The truss ***ABC*** shown in **Fig. 2** supports a force ***P*** at joint ***B*** that acts at an angle θ to the vertical. $0^0 \le \theta \le 90^0$ and θ is positive as shown. The cross-sectional areas and moduli of elasticity of members ***AB*** and ***BC*** are the same.
Find θ so that the deflection of the joint *B* will be in the same direction as the force *P*.

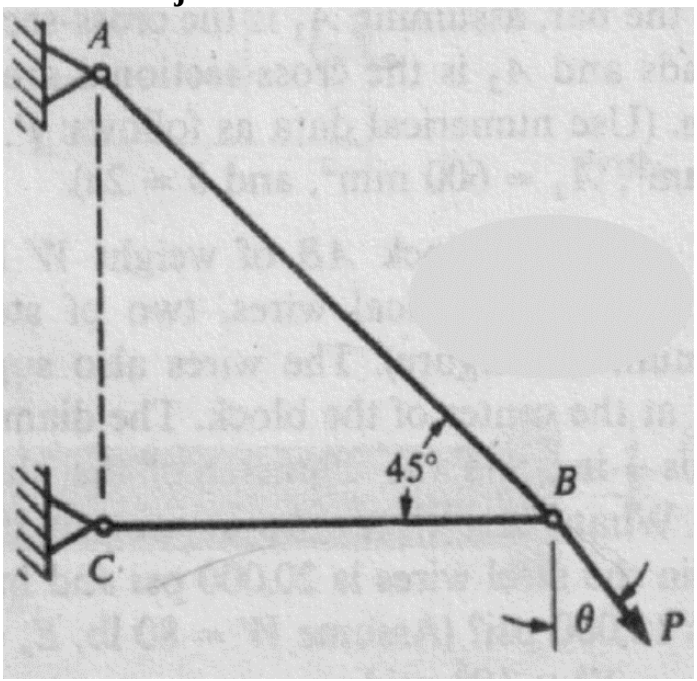

Fig. 2

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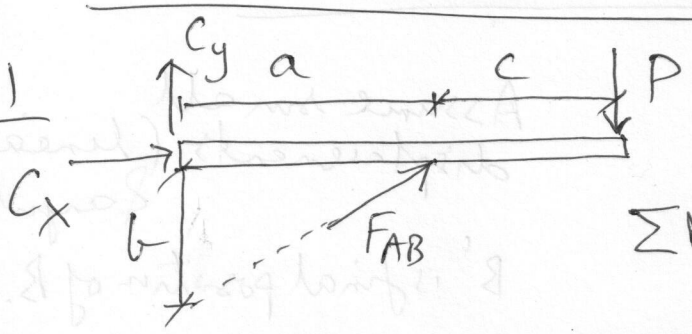


AB is 2-force member.

$$\Sigma M_C = 0 \Rightarrow F_{AB} = \frac{P(a+c)}{(a)(b)/\sqrt{a^2+b^2}}$$

$$\Sigma F_x = 0 \Rightarrow C_x = -F_{AB}\frac{a}{\sqrt{a^2+b^2}}$$

$$\Sigma F_y = 0 \Rightarrow C_y = P - F_{AB}\frac{b}{\sqrt{a^2+b^2}}$$

$$C = \sqrt{\left(F_{AB}\frac{a}{\sqrt{a^2+b^2}}\right)^2 + \left(P - F_{AB}\frac{b}{\sqrt{a^2+b^2}}\right)^2}$$

$$\tau_A = \frac{F_{AB}}{2\frac{\pi}{4}(d_A)^2}, \quad \tau_c = \frac{C}{\frac{\pi}{4}(d_c^2)}$$

Code A:	$\tau_A = 53.05$,	$\tau_c = 12.30$	MPa
B:	$= 33.47$,	$= 105.97$	
C:	$= 19.93$,	$= 36.46$	
D:	$= 108.89$,	$= 49.12$	

$F_{AB} = 1500$, $C = 1236.93$

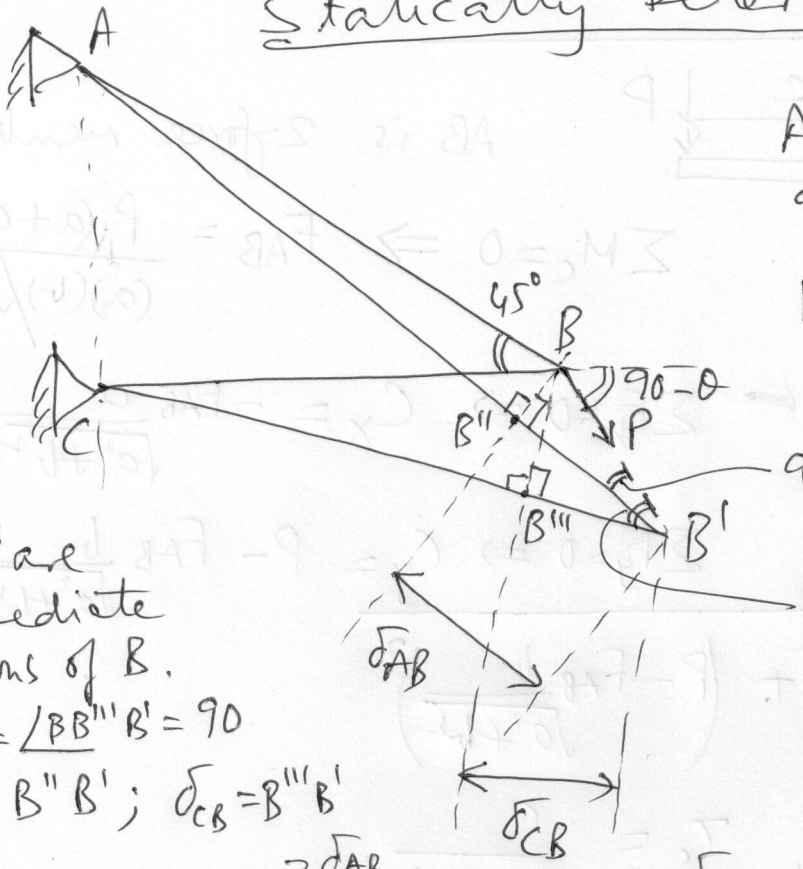
$= 3365.18$ $= 2996.29$

$= 1565.25$ $= 1431.78$

$= 4276.03$ $= 3858.04$

N.

Statically Determinate



Assume small displacements (linear & angular).

B' is final position of B.

B'', B''' are intermediate positions of B.

$\angle BB''B' = \angle BB'''B' = 90$

$\delta_{AB} = B''B'$; $\delta_{CB} = B'''B'$

Geometry shown is for B displacing in direction of P

$$BB' = \frac{B''B' \to \delta_{AB}}{\cos(45-\theta)} = \frac{B'''B' \to \delta_{CB}}{\cos(90-\theta)} \quad \leftarrow \text{Compatibility}$$

$$= \frac{F_{AB} L\sqrt{2}}{\frac{c\theta}{\sqrt{2}} + \frac{s\theta}{\sqrt{2}}} = \frac{F_{CB} L}{s\theta} \longrightarrow (1)$$

Equilibrium: (method of joints) (compatibility not required to solve for member forces).

$$\Sigma F_y: \frac{F_{AB}}{\sqrt{2}} = P\cos\theta \quad ; \quad \Sigma F_x: F_{CB} + \frac{F_{AB}}{\sqrt{2}} = P\sin\theta$$

$$\Rightarrow F_{CB} = P(s\theta - c\theta) \longrightarrow (2)$$

$$(1), (2) \longrightarrow \frac{P(s\theta - c\theta)L}{s\theta} = \frac{P\sqrt{2}\, c\theta - L\sqrt{2}}{(c\theta + s\theta)/\sqrt{2}}$$

$$\Rightarrow \tan 2\theta = -1/\sqrt{2} \Rightarrow 2\theta = -35.26^\circ, 144.73^\circ$$

$$0 \le \theta \le 90 \Rightarrow \boxed{\theta = \frac{144.73}{2} = 72.37^\circ}$$