TOBB EKONOMİ VE TEKNOLOJİ ÜNİVERSİTESİ

Department of Mechanical Engineering

MAK 206 STRENGTH OF MATERIALS

2012- 2013 Spring Semester
Final

Dr. Mehmet Ali Güler

27 Mart 2013, Çarşamba

Name Şebbattin Şahan GÜKSEL

Student # 101501026

Duration of Examination: **2.5 hours** (14:30-17:00)

QUESTION	Maximum Point	Points
1	30	27
2	30	26
3	30	29
4	30	27
Total	120	

ÖNEMLİ UYARI !!!

Yükseköğretim Kurumları Öğrenci Disiplin Yönetmeliği Madde 9-m'ye göre "sınavlarda kopya yapmak veya yaptırmak veya bunlara teşebbüs etmek" fiilinin suçu YÜKSEKÖĞRETİM KURUMUNDAN BİR VEYA İKİ YARIYIL İÇİN UZAKLAŞTIRMA cezasıdır.

Özel Sınav Kuralları:
Sınav süresince cep telefonları kapalı konumda olmak suretiyle sıra üzerine konulmalıdır.

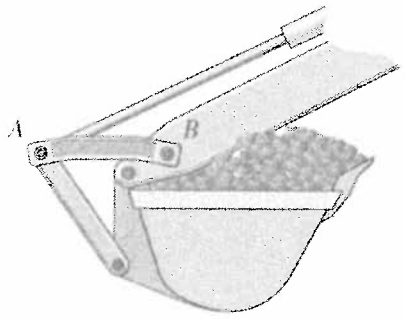
UYARI VE KURALLARI OKUDUM.

Öğrencinin İmzası:
Adı Soyadı .....

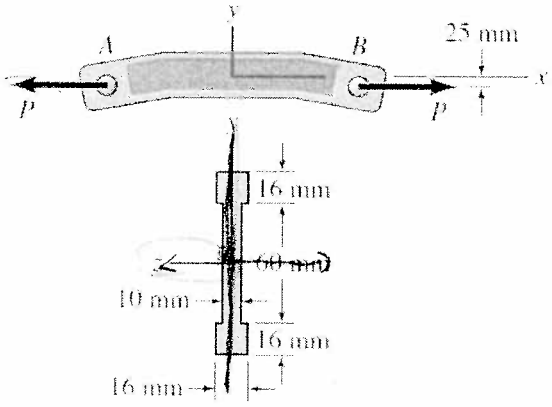
Ön sayfa dahil, bu sınav kağıdında toplam **(10)** sayfa vardır.

Student #: .....

Question 1: (30 **points)**

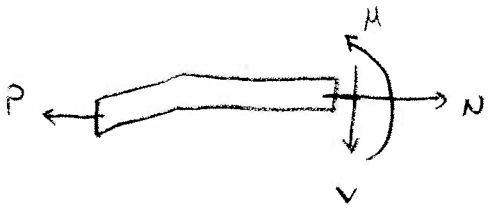


(a)



(b)

One part of the mechanism that controls the operation of the backhoe bucket in Fig. a is the (slightly C-shaped) two-force link AB, whose dimensions are shown in Fig. b. (a) Determine the maximum tensile stress on the cross section at the center of link AB if the force exerted on the link by the pins at A and B is P=6 kN. Show the state of stress on a differential element and draw the Mohr's circle **for maximum tensile stress point**. (b) How much would the maximum tensile stress be if the link were perfectly straight, with the same cross-sectional dimensions?



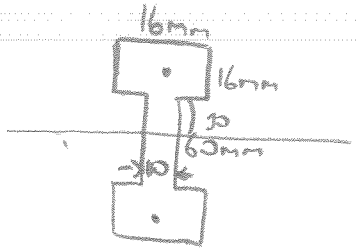
$\stackrel{+}{\rightarrow} \Sigma f_x = 0 \Rightarrow N - P = 0 \quad N = P = 6kN$

$+\uparrow \Sigma f_y = 0 \Rightarrow V = 0$

$\zeta^+ \Sigma M = 0 \Rightarrow M - 6000.15$

$M = 150 Nm$

=> Devamı Arka dyfada



Şekil simetrik olduğu için tarafsız eksen tam orta noktadadır.

$$I = 2\left(\underbrace{\frac{1}{12}.16.16^3}_{5461,333} + \underbrace{16.16.38^2}_{369664}\right) + \underbrace{\frac{1}{12}.10.60^3}_{180000}$$

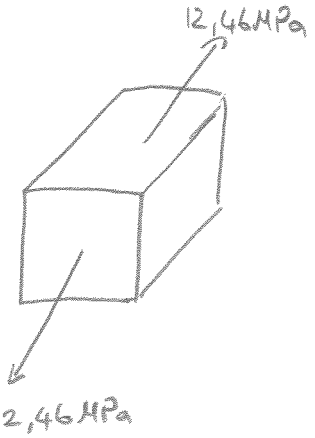
$$\underbrace{\qquad\qquad\qquad\qquad}_{750250,666}$$

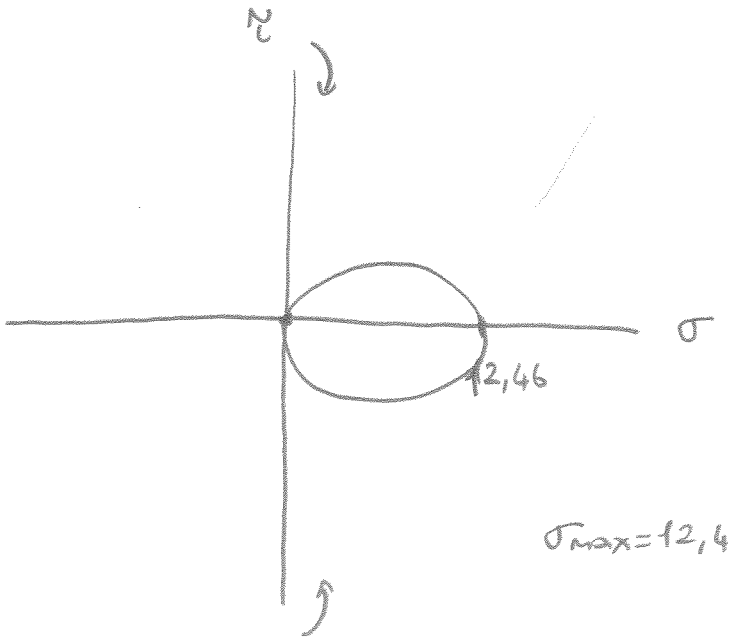
$$I = 930250,666 mm^4$$

$$\sigma_1 = \frac{P}{A} = \frac{6000}{2.16.16 + 60.10} = \frac{6000}{1112} = 5,4 MPa$$

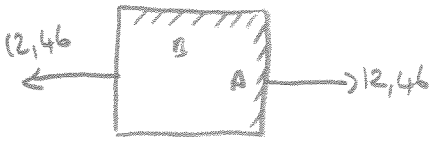
$$\sigma_2 = \frac{Mc}{I} = \frac{150000.46}{930250,666} = 7,42 MPa$$

$$\sigma_{max} = \sigma_1 + \sigma_2 = 7,42 + 5,04 = 12,46 MPa$$





$\sigma_{max} = 12,46 MPa$

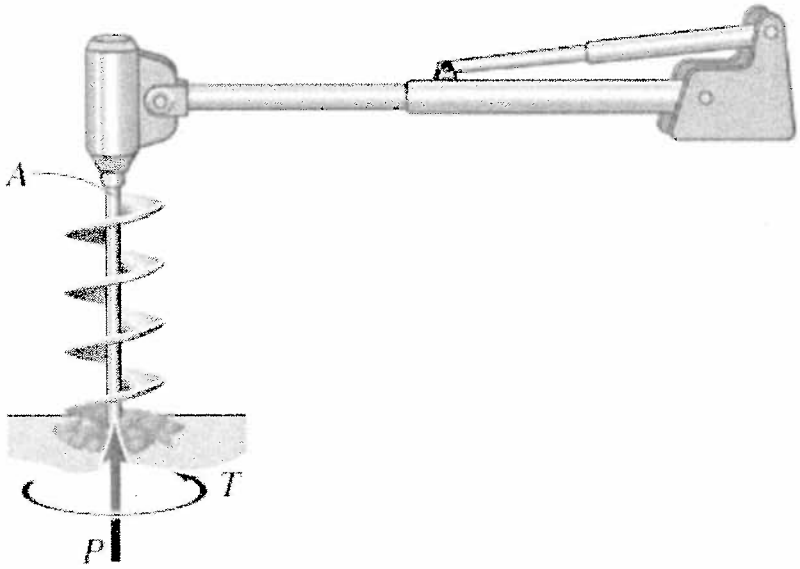


⇒ Devamı Diğer Sayfada

b) $\sigma = \frac{P}{A} = \frac{6000\,N}{2 \cdot 16 \cdot 16 + 60 \cdot 10} = 5{,}4\,MPa$

Student #: .....

Question 2: (30 points)

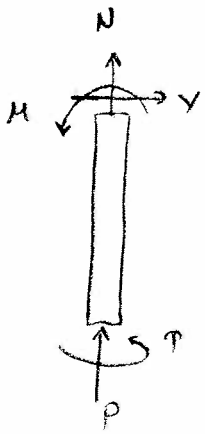


A post-hole digger is mounted on a tractor (not shown).The power unit of the machine consume 1 kW of power while the shaft is turning at a speed of 10 RPM(revolutions per minute) and it also exerts a downward force of $P = 6$ kN on the auger. If the shaft of the auger is a solid circular rod with a diameter of 50 mm., determine the principal stresses and the maximum shear stress at a typical point A on the surface of the shaft of the auger near the power unit. Show the state of stress on a differential element and draw the Mohr's circle for point A (**at the perimeter of the circular cross-section**).

Power (N.m/s) = Torque (N.m) x Angular velocity (Rad/s)

$1kw = 1000 \frac{Nm}{s}$

$1\text{RPM} = \frac{2\pi}{60}\text{ Rad/s}$



$+\uparrow \Sigma f_y = 0 = P - N = 0$

$P = N \Rightarrow N = 6kN$

$\pm \rightarrow \Sigma f_x = 0 \Rightarrow V = 0$

$\zeta + \Sigma T = 0 \Rightarrow M - T = 0$

$M = T$

güç

$\hat{P} = T \cdot w$

$\frac{1000Nm}{s} = T \cdot 10 \cdot \frac{2\pi}{60}$

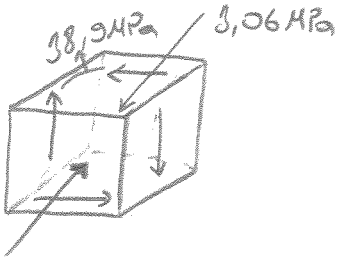
$T = 954,93 N.m$

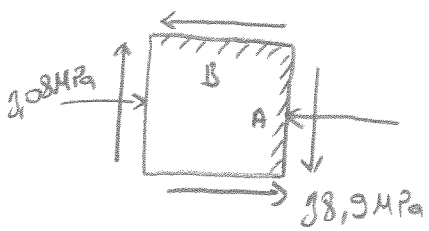
=> Devamı Arkada

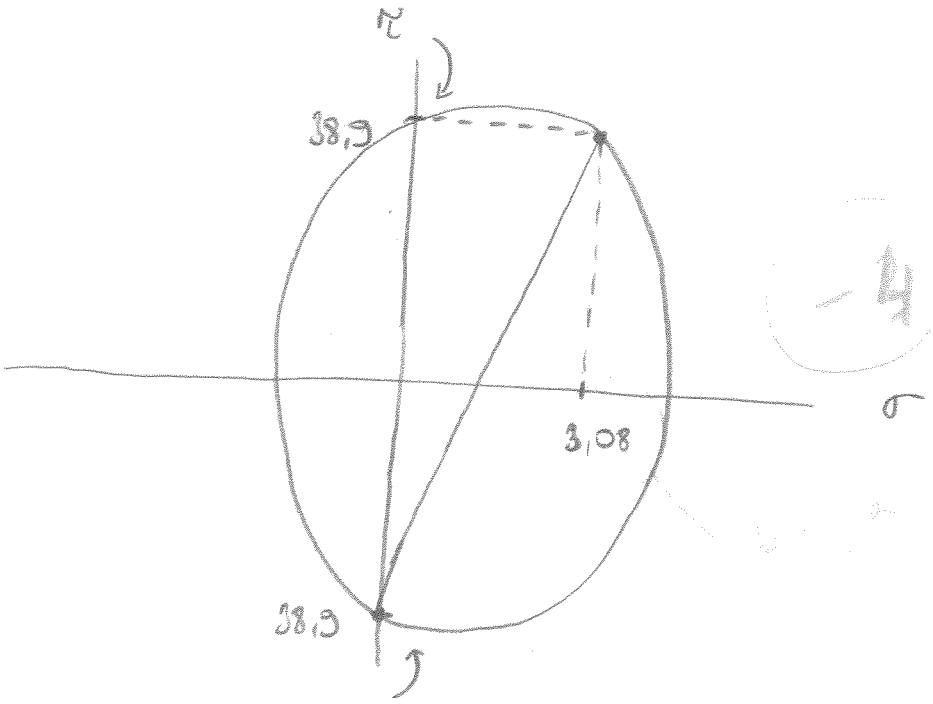
$$\sigma = \frac{P}{A} = \frac{6000}{\frac{\pi}{4}(50)^2} = 3,06\,MPa$$

$$J = \frac{\pi}{2} c^4 = \frac{\pi}{2} \cdot (25)^4 = 613592,32\,MPa$$

$$\tau = \frac{Tc}{J} = \frac{954930.25}{613592,32} = 38,9\,MPa$$

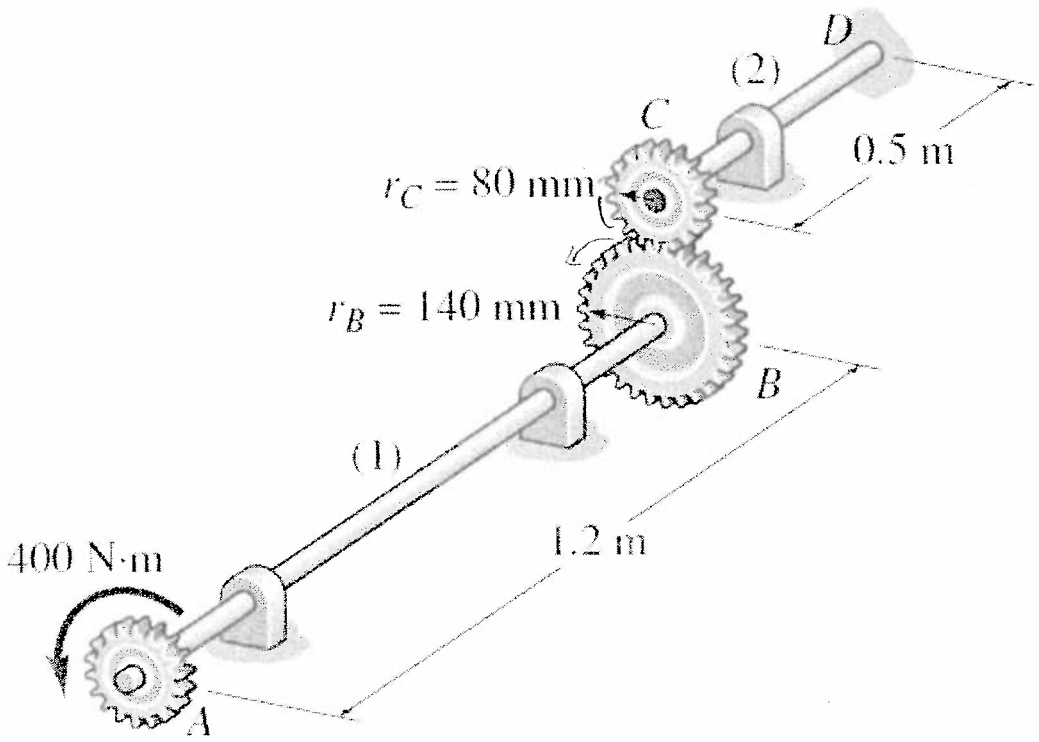






Student #: .....

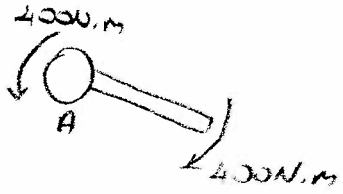
Question 3: (30 points)



A torque is applied to gear A of a two-shaft system and is transmitted through gears at B and C to a fixed end at D. The shafts are made of steel (G = 80 GPa). Each shaft has a diameter d = 32 mm, and they are supported by frictionless bearings as shown in Figure. If the torque applied to gear A is 400 Nm, and D is restrained, (a) determine the maximum shear stress in each shaft, and (b) determine the angle of twist of the gear A relative to its no-load position. Show the state of stress on a differential element and draw the Mohr's circle for the point where maximum shear stress occurs.

* Maximum shear stres en dış çark A çarkında oluşur

A çarkı için;



C çarkı için önce tork hesaplamak lazım 228,6Nm 226,N.m

$\tau = \frac{400}{0,14} \cdot 0,08 = 228,6\ N.m$

==> Devamı Arka Sayfada

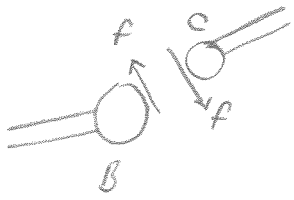
$$\tau_{max} = \frac{T \cdot c}{J}$$

$$J = \frac{\pi}{2} c^4 = \frac{\pi}{2} \cdot 16^4 = 102943,7 \text{ mm}^4$$

a) $$\tau_{max} = \frac{400000 \cdot 16}{102943,7} = 62,2 \text{ MPa}$$

b) Park A garkından B garkına iletilir. B ve C garkları arasında bir kuvvet oluşur,

$$f = \frac{400 \text{ N.m}}{0,14 \text{ m}} = 2857,14 \text{ N}$$



C'de oluşan tork;

$$T = f.r = 2857,14 \text{ N} \cdot 0,08 \text{ m} = 228,6 \text{ N.m}$$

$$\phi = \frac{T \cdot L}{J \cdot G} \Rightarrow \phi_C = \frac{228,6 \text{ N.m} \cdot 0,5 \text{ m}}{102943,7 \cdot 10^{-12} \cdot 80,10^9} = 0,014$$

$$\phi_B \cdot 0,14 = 0,014 \cdot 0,08$$

$$\phi_B = 8,10^{-3}$$

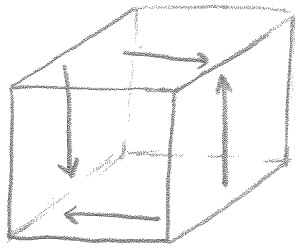
$$\phi_{B/A} = \frac{400 \text{ N.m} \cdot 1,2 \text{ m}}{102943,7 \times 10^{-12} \cdot 80 \times 10^9} = 0,058$$

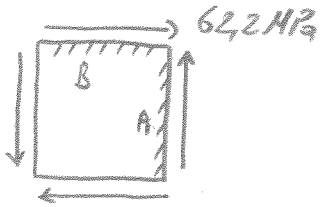
$$\phi_A = \phi_B + \phi_{B/A} = 0,058 + 0,008 = 0,066$$

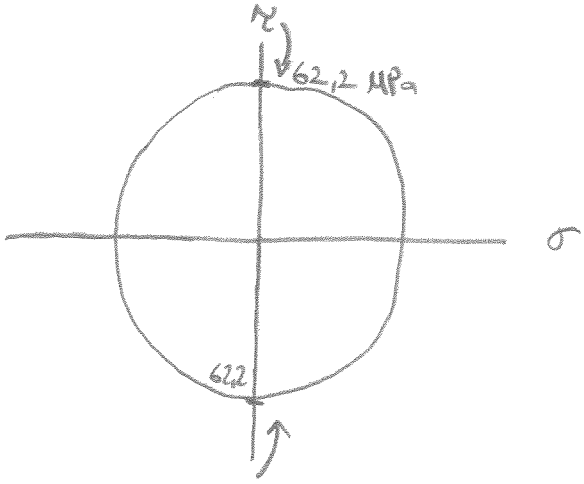
$$\delta = \phi \cdot r = 0,066 \cdot 140 = 9,24 \text{ mm}$$

Devamı Diğer Sayfada

A ve B için Ayrıdın.

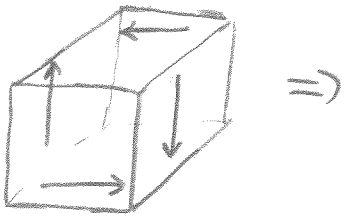


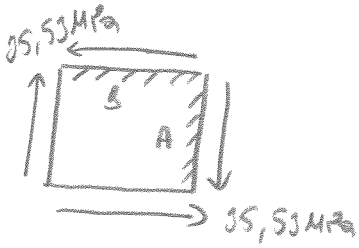




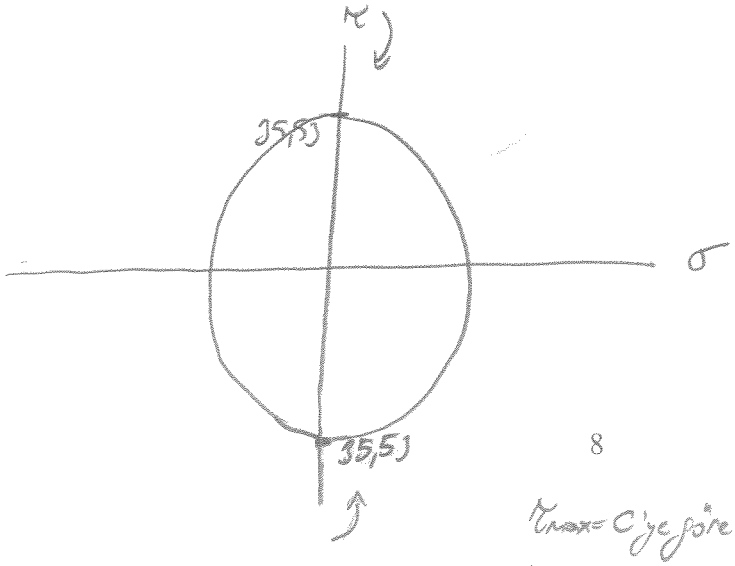
$\tau_{max} = 62,2\ MPa$

C için;





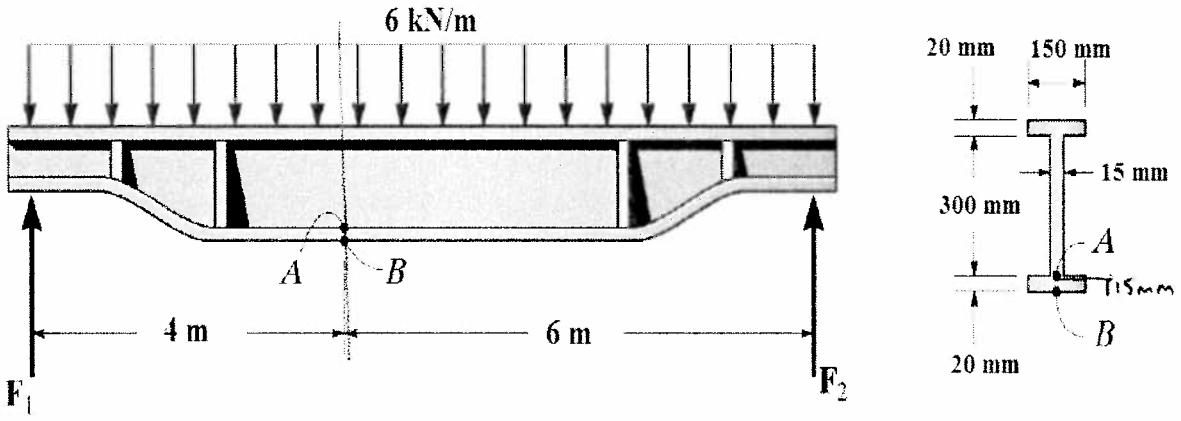
$$\tau = \frac{T \cdot c}{J} = \frac{228,6 \cdot 16}{\frac{\pi}{2} \cdot 16^4} = 35,53\ MPa$$



τ_{max} = Çıkışta $35,53\ MPa$

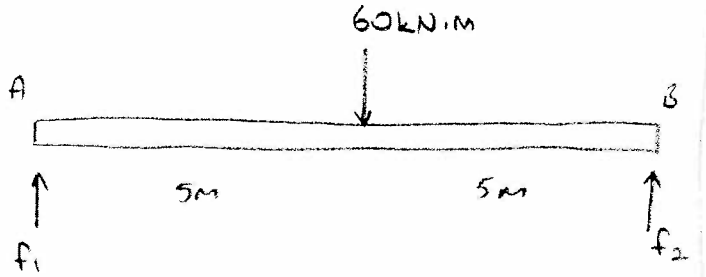
Student #: .....

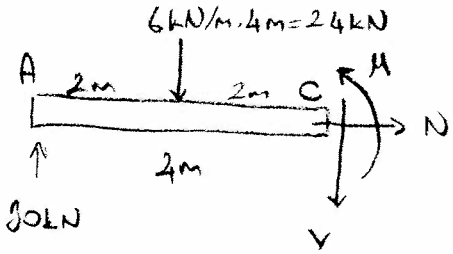
Question 4: (30 points)



The bolster or main supporting girder (chassis) of a truck body is subjected to the uniform distributed load. Draw the shear and moment diagrams for the bolster (chassis). Determine **the bending stress and the transverse shear stress** at points A and B. (Note: the thickness at point A is 15 mm.)

Kesitgimiz ilk 4m'lik kisim alinir.





$\zeta^+ \Sigma M_A = 0 = 10 f_2 - 60.5$

$f_2 = 30kN$

$+\uparrow \Sigma f_y = 0 = f_1 + 30 - 60 = 0$

$f_1 = 30kN$

$\pm \Sigma f_x = 0 = N = 0$

$+\uparrow \Sigma f_y = 0 = 30 - 24 - V = 0 \Rightarrow V = 6kN$

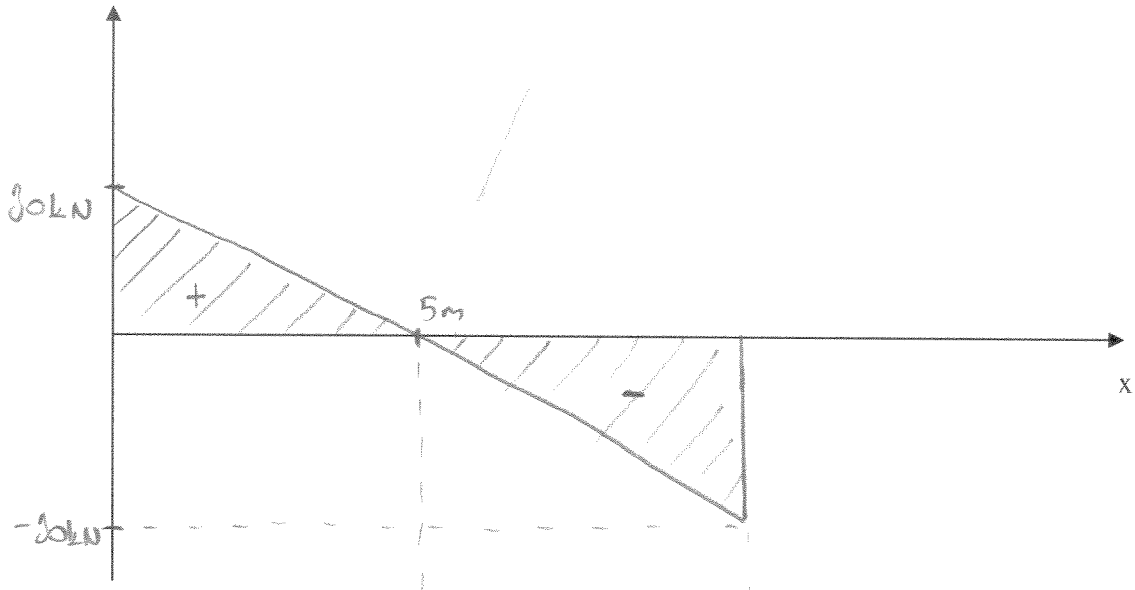
$\zeta^+ \Sigma M_C = 0 = -30.4 + 24.2 + M = 0$

$M = 120 - 48 = 72kN.m$

* bending stress ve transverse shear hesaplari en sayfada ! ⇒

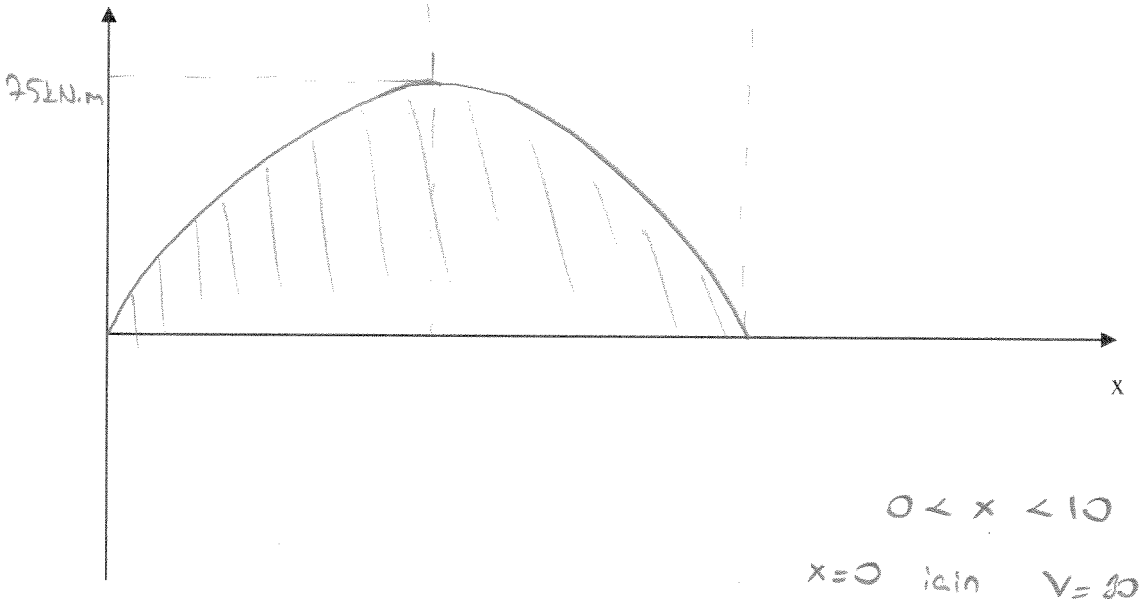
Student #: .....

V (Shear Force)



V grafiğinin altında kalan alan momenti verir.

Moment



$0 < x < 10$

$x=0$ için $V=30kN$,

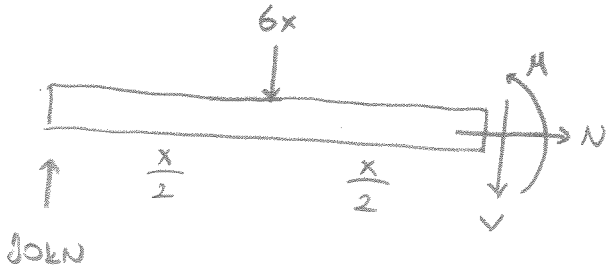
$M=0$,

$x=5$ için $V=0$

$M=75kN.m$

$x=10$ için $V=-30$

$M=0$

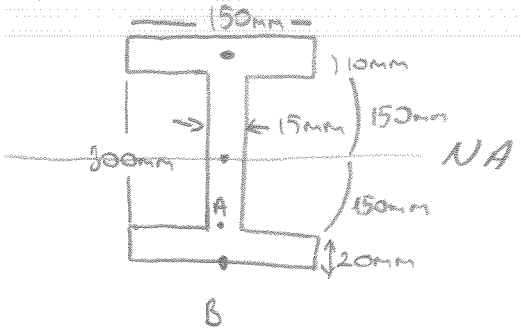


$\pm \Sigma f_x = 0 \quad N=0$

$+\uparrow \Sigma f_y = 0 \Rightarrow 30 - 6x - V = 0$ $\boxed{V = 30 - 6x}$

$\circlearrowleft + \Sigma M = 0 \Rightarrow \left(M - 30.x + 6x.\frac{x}{2}\right)$

$\boxed{M = 30x - 3x^2}$



* Şekil simetrik olduğu için tarafsız eksen tam orta noktadadır.

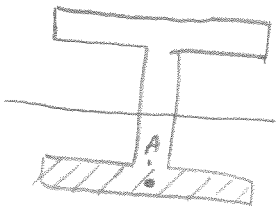
$$I = \frac{1}{12} \cdot bh^3 + A d^2$$

$$I = \left[\left(2 \cdot \frac{1}{12} \cdot 150 \cdot 20^3\right) + 150 \cdot 20 \cdot (160)^2\right] + \left(\frac{1}{12} \cdot 15 \cdot 300^3\right)$$

200000 $\quad$ 76800000 $\quad$ 33750000

$$I = 110750000\ mm^4$$ X (-3)

A noktası için



$$Q_A = \bar{y} \cdot A$$

$$Q_A = 160mm \cdot 150mm \cdot 20mm = 480000\ mm^3$$ ✓

$t = 15mm$

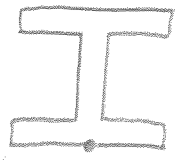
$$\tau_A = \frac{V \cdot Q}{I \cdot t} = \frac{6000 \cdot 480000}{110750000 \cdot 15} = 1,734\ MPa$$ X

$$\sigma_A = \frac{M \cdot c}{I} = \frac{72000000 \cdot 150}{110750000} = 97,5\ MPa$$

B noktası için;

$Q = 0$ $\Rightarrow$ A=0 'dır. Altında kalan alan yoktur.

$\tau_B = 0$



B $\rightarrow$ Altında kalan Alan=0

$$\sigma_B = \frac{M \cdot c}{I} = \frac{72000000 \cdot 170}{110750000} = 110,5\ MPa$$