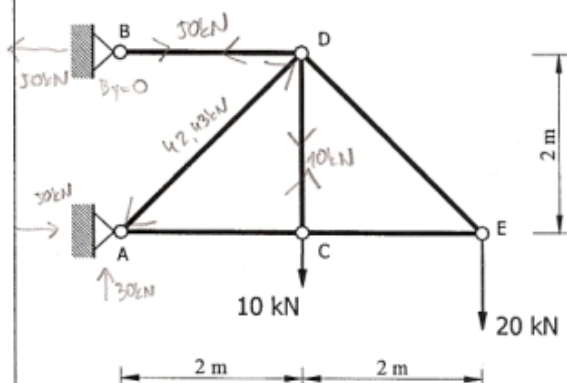


Ime in priimek:  
Vpisna št.:

### 1. Naloga (40 točk)

Za palični nosilec na spodnji sliki izračunaj:

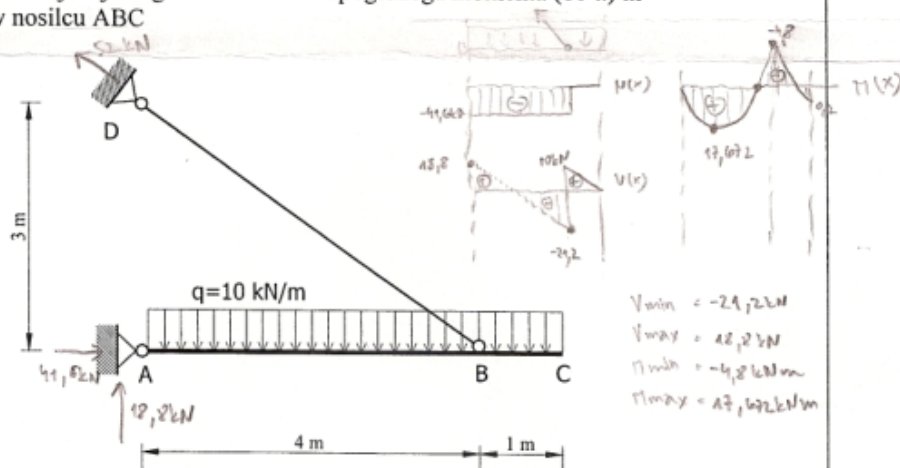
- 1.1 Stopnjo statične (ne)določenosti (10 t.)  $\circ = 0$
- 1.2 Reakcije (10 t.)
- 1.3 Osne sile v palicah AD, BD in CD (20 t.)



### 2. Naloga (60 točk)

Za nosilec na spodnji sliki izračunaj:

- 2.1 Stopnjo statične (ne)določenosti (10 t.)  $\circ = 0$
- 2.2 Reakcije (10 t.)
- 2.3 Diagrame notranjih statičnih količin (upogibnih momentov, prečnih sil in osnih sil) za nosilec ABC (20 t.)
- 2.4 Največjo pozitivno in največjo negativno vrednost upogibnega momenta (10 t.) in prečne sile (10 t.) v nosilcu ABC



Naloge skupaj štejejo 100 točk, 50 točk je pozitivno.

Na vsako stran zapišite zaporedno številko strani, svoje ime in št. indeksa! Izračun nalog naslovite s številko naloge in točko, ki jo računate, končni rezultat pa 2x podčrtajte oz. uokvirite.

Rezultati bodo objavljeni v sredo, 18. 6. 2008 na spletnih straneh FG, kjer bo objavljen tudi čas ustnega zagovora.

Na ustni zagovor prinesite SEMINARSKO NALOGO in rešene naloge tega izpita!

1. Naloga



1.1

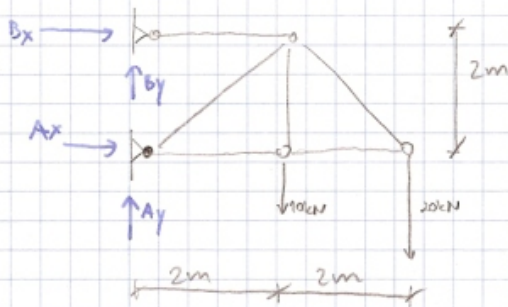
$j_2 = 5$   
 $m_4 = 6$   
 $p = 4$

$n = 4 + 3 \cdot (0 - 0) + 2 \cdot (0 - 5) + 1 \cdot (6 - 0)$

$n = 4 + 0 - 10 + 6 = 0$

statično določena konstrukcija

1.2 Reakcije



$\sum F_x = 0$

$A_x + B_x = 0$

$B_y = 0$  → iz notranji metode →

$\sum F_y = 0$

$A_y + B_y - 10\text{kN} - 20\text{kN} = 0$

$A_y + B_y = 30\text{kN}$

$A_y = 30\text{kN}$

$\sum M^A = 0$

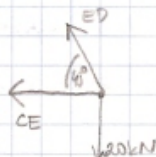
$-B_x \cdot 2\text{m} - 10\text{kN} \cdot 2\text{m} - 20\text{kN} \cdot 4\text{m} = 0$

$B_x = -50\text{kN}$

$A_x = -B_x = 50\text{kN}$

1.3 Sila v polihedri AD, BD in CD

• razlišče E



$\sum F_x = 0$

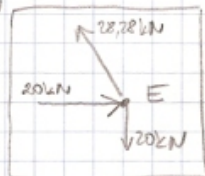
$-CE - ED \cdot \cos 45^\circ = 0$

$CE = -20\text{kN} \text{ (tlač)}$

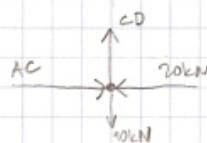
$\sum F_y = 0$

$ED \cdot \sin 45^\circ = 20\text{kN}$

$ED = \frac{20\text{kN}}{\sin 45^\circ} = 28,28\text{kN}$



• razlišče C



$\sum F_y = 0$

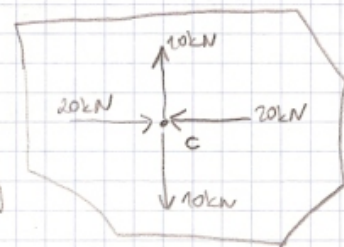
$CD - 10\text{kN} = 0$

$CD = 10\text{kN}$

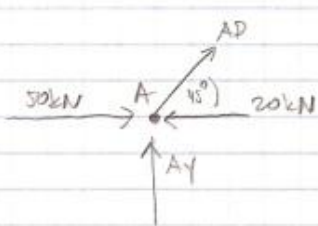
$\sum F_x = 0$

$AC - 20\text{kN} = 0$

$AC = 20\text{kN}$



• nodus A

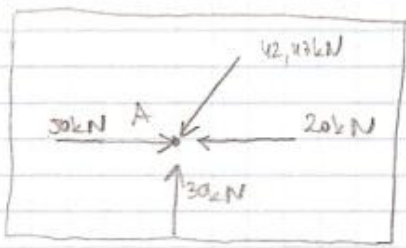


$\sum F_x = 0$

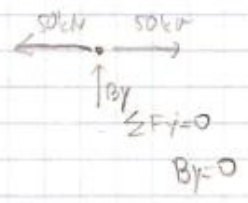
$-20 \text{ kN} + 30 \text{ kN} + AD \cdot \cos 45^\circ = 0$   
 $AD \cdot \cos 45^\circ = -30 \text{ kN}$   
 $AD = -42,43 \text{ (Tekan)}$

$\sum F_y = 0$

$Ay + AD \cdot \sin 45^\circ = 0$   
 $Ay = -\sin 45^\circ \cdot AD$   
 $Ay = -\sin 45^\circ \cdot (-42,43)$   
 $Ay = 30 \text{ kN}$



• nodus B



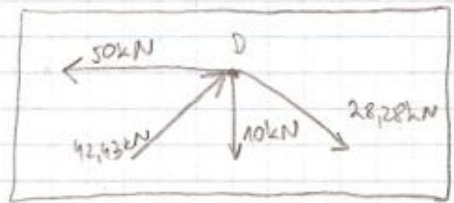
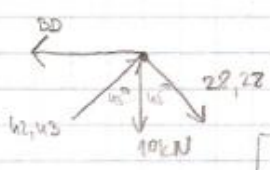
$\sum F_y = 0$   
 $By = 0$

• nodus D

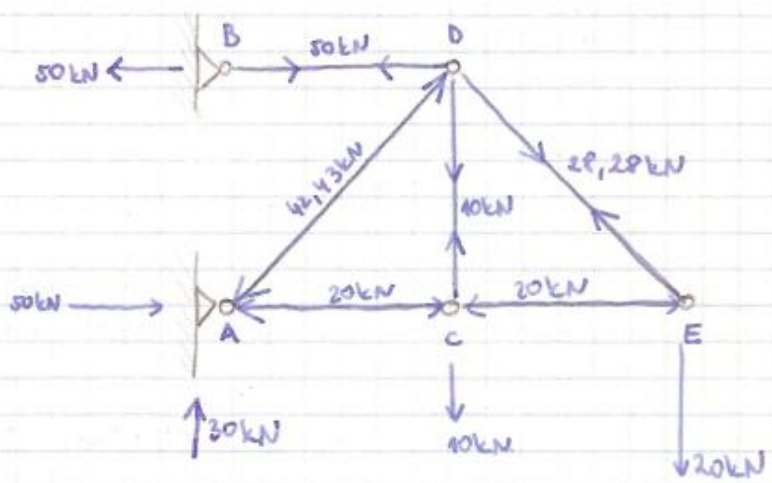
$\sum F_x = 0$

$28,28 \cdot \sin 45^\circ + 42,43 \cdot \sin 45^\circ - BD = 0$

$BD = 49,99952 \text{ kN} \approx 50 \text{ kN}$



Resultat:



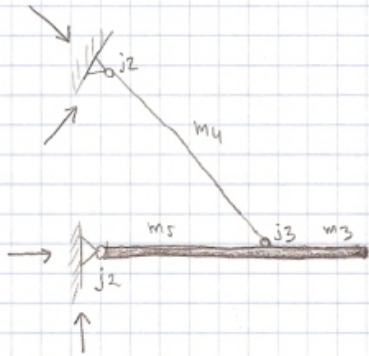
- AD = 42,43 kN (Tekan)
- BD = 50 kN (Tarik)
- CD = 10 kN (Tarik)



## 2. naloga

3

### 2.1) Statična (ne)določnost



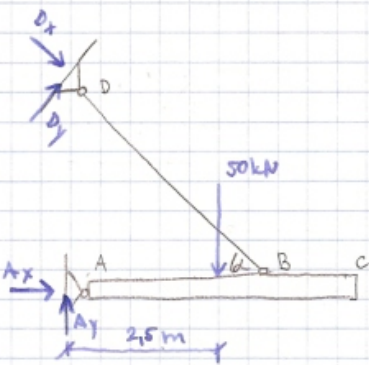
$p=4$

$$\begin{matrix} m_0 = \emptyset & j_3 = 1 \\ m_5 = 1 & j_2 = 2 \\ m_4 = 1 & j_1 = \emptyset \end{matrix}$$

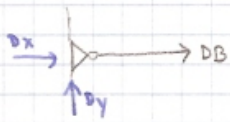
$$n = 4 + 3 \cdot (0 - 1) + 2 \cdot (1 - 2) + 1 \cdot (1 - 0)$$

$$n = 4 - 3 - 2 + 1 = 0 \quad \text{statično določna konstrukcija}$$

### 2.2.) Reakcije



• nosilcu D

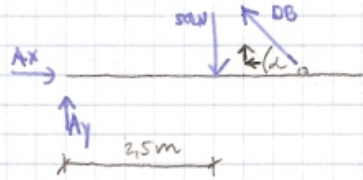


• vrvi! - sila deluje samo na vrvi smenu.

$$\begin{matrix} \sum F_y = 0 \\ D_y = 0 \end{matrix}$$

$$D_x = -DB$$

• element ABC



$$\sum F_x = 0$$

$$A_x - DB \cdot \cos 36,87^\circ = 0$$

$$A_x = DB \cdot \cos 36,87^\circ$$

$$\sum F_y = 0$$

$$A_y + DB \cdot \sin 36,87^\circ = 50 \text{ kN}$$

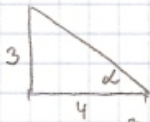
$$\sum M^A = 0$$

$$DB \cdot \sin 36,87^\circ \cdot 4 \text{ m} - 50 \text{ kN} \cdot 2,5 \text{ m}$$

$$DB = 52,08 \text{ kN}$$

$$A_x = 41,67 \text{ kN}$$

$$A_y = 18,75 \text{ kN}$$



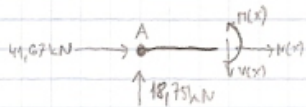
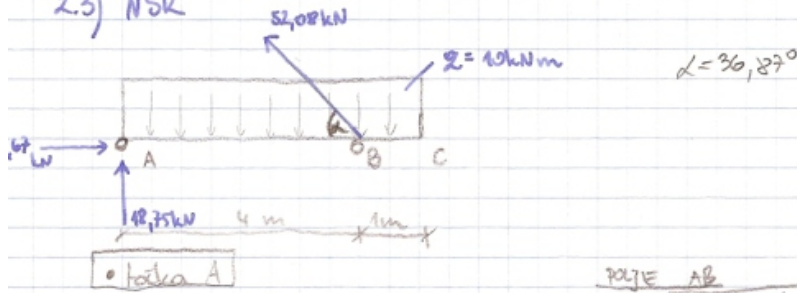
$$\tan \alpha = \frac{3}{4}$$

$$\alpha = \arctan \frac{3}{4} = 36,87^\circ$$



2.3) NSK

4



rovní podmínky:

$$\begin{aligned} N(x) &= 49.67 \text{ kN} = N_A^D \\ V(x) &= 18.75 \text{ kN} = V_A^D \\ M(x) &= 0 \text{ kNm} = M_A^D \end{aligned}$$

podmínky

$$0 \leq x \leq 4$$

polje AB

$N(x) = N_A^D = 49.67 \text{ kN}$  → ar km poříjje ne delorrali dunge horizontalske síle

$$V(x) = \int (-q(x)) dx = \int (-10) dx = -10x + C$$

$$V(x=0) = V_A^D = 18.75 \text{ kN} = -10 \cdot 0 + C \Rightarrow C = 18.75 \text{ kN}$$

$$V(x) = -10x + 18.75 \text{ [kN]}$$

$$M(x) = \int V(x) dx = \int (-10x + 18.75) dx = -5x^2 + 18.75x + C$$

$$M(x=0) = M_A^D = 0 = -5 \cdot 0^2 + 18.75 \cdot 0 + C \Rightarrow C = 0$$

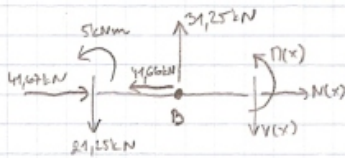
$$M(x) = -5x^2 + 18.75x \text{ [kNm]}$$

• točka B

$$N(x) = N_B^D = -49.67 \text{ kN}$$

$$V(x=4) = N_B^D = -10 \cdot 4 + 18.75 = -21.25 \text{ kN}$$

$$M(x=4) = N_B^D = -5 \cdot 4^2 + 18.75 \cdot 4 = -5 \text{ kNm}$$



$$\sum F_x = 0$$

$$V(x) + 49.67 \text{ kN} - 49.67 \text{ kN} = 0$$

$$N(x) = 0 \text{ kN} = N_B^D$$

$$\sum F_y = 0$$

$$V(x) + 21.25 \text{ kN} - 21.25 \text{ kN} = 0$$

$$N(x) = 10 \text{ kN} = V_B^D$$

$$\sum M = 0$$

$$M(x) + 5 \text{ kNm} = 0$$

$$M(x) = -5 \text{ kNm} = M_B^D$$

rovní

podmínky:

$$0 \leq x \leq 1$$

polje BC

$N(x) = N_B^D = 0 \text{ kN}$  - hi horizontalskih síl

$$V(x) = \int (-q(x)) dx = \int (-10) dx = -10x + C$$

$$V(x=0) = V_B^D = 10 \text{ kN} = -10 \cdot 0 + C \Rightarrow C = 10 \text{ kN}$$

$$V(x) = -10x + 10 \text{ [kN]}$$

$$M(x) = \int V(x) dx = \int (-10x + 10) dx = -5x^2 + 10x + C$$

$$M(x=0) = M_B^D = -5 \text{ kNm} = -5 \cdot 0^2 + 10 \cdot 0 + C \Rightarrow C = -5$$

$$M(x) = -5x^2 + 10x - 5 \text{ [kNm]}$$

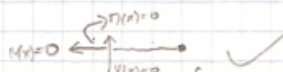
✓ za kontrolu

• točka C

$$N(x) = 0 \text{ kN}$$

$$V(x=1) = -10 \cdot 1 + 10 = 0 \text{ kN}$$

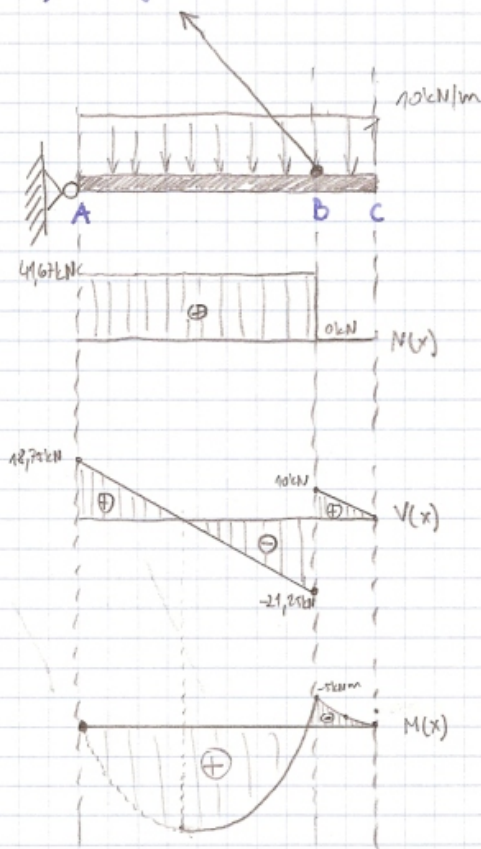
$$M(x=1) = -5 \cdot 1^2 + 10 \cdot 1 - 5 = 0 \text{ kNm}$$



→ hi net síl hi hi delorrali ar hi skrajni točki

### 2.3) Diagrami NSK- za nosilec ABC

5



$\Pi(x=0) = 0 \text{ kNm}$   
 $\Pi(x=4) = -5 \text{ kNm}$   
 $\Pi(x=1.875) = 17.58 \text{ kNm}$

POLJE AB: pogoj:  $0 \leq x \leq 4$   
 $N(x) = 41,67 \text{ kN}$   
 $V(x) = -10x + 18,75 \text{ [kN]}$   
 $M(x) = -5x^2 + 18,75 \cdot x \text{ [kNm]}$

POLJE BC: pogoj:  $0 \leq x \leq 1$   
 $N(x) = 0 \text{ kN}$   
 $V(x) = -10x + 10 \text{ [kN]}$   
 $M(x) = -5x^2 + 10x - 5 \text{ [kNm]}$

### 2.4) Ekstremi

Ekstremne vrednosti bodo v polju AB:

$\Rightarrow V(x)_{\min, \max} = V(x) = 0$

$V(x) = -2(x)$

$-10 = 0 ? \rightarrow$  ne obstajajo točkodi  $\rightarrow$  iz diagrama:

$V_{\max} = V(x=0) = 18,75 \text{ kN}$   
 $V_{\min} = V(x=4) = -21,25 \text{ kN}$

$\Rightarrow \Pi(x)_{\min, \max} = \Pi(x) = 0$

$\Pi'(x) = V(x)$

$-10x + 18,75 = 0$

$-10x = -18,75$

$x = 1,875$

$\Pi(x=1,875) = 17,58 \text{ kNm} = \Pi_{\max}$

$\Pi_{\min} = -5 \text{ kNm}$  iz diagrama