

بسمه تعالی

جزوه

استاتیک

دانشگاه

صنعتی امیرکبیر

استاد

دکتر اقدم

Subject:

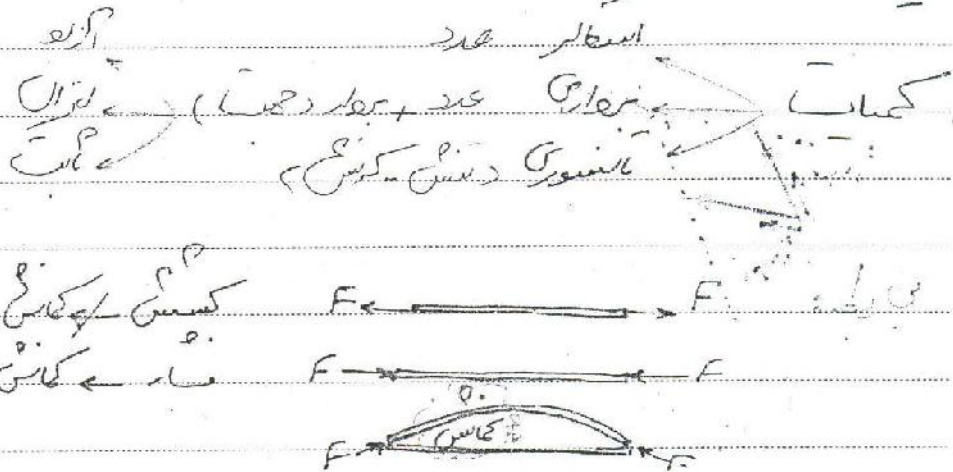
Year. Month. Date. ()

استاتیک اقدام:

مختصات: دینامیک (در بیان) در بیان استاتیک و دینامیک

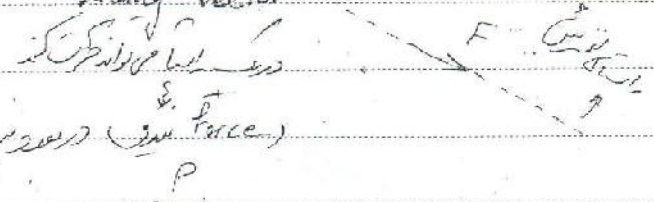
در / هم صاف / هم انحراف پذیر

باید همه اجزای و توزیع هم برای ما هم است و توانم هم را در تصویر کنیم



مکان در حرکت و استاتیک در حرکت و استاتیک در حرکت

آزاد \vec{F} \vec{v} \vec{a} \vec{r} \vec{p} \vec{m} \vec{F} \vec{v} \vec{a} \vec{r} \vec{p} \vec{m}
 static vector \vec{F} \vec{v} \vec{a} \vec{r} \vec{p} \vec{m} \vec{F} \vec{v} \vec{a} \vec{r} \vec{p} \vec{m}
 Fixed sliding vector



در / هم صاف / هم انحراف پذیر
 استاتیک: $\vec{A} \cdot \vec{B}$ $\vec{A} \times \vec{B}$ $\vec{A} \cdot \vec{B}$ $\vec{A} \times \vec{B}$

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$$\vec{M} = \vec{r} \times \vec{F}$$

سازگار: -

$$A \cdot B \cdot C \times (A \times B) \cdot C \checkmark$$

$$\rightarrow A \times B \cdot C \checkmark$$

①

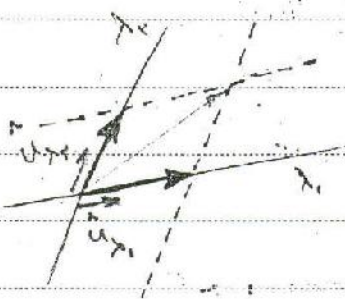
$$\vec{A} \cdot \vec{B} = P$$

$$\vec{A} \times \vec{B} = M$$

* سازگار است و جهت هم دارد

$$\vec{A} \times \vec{B} \cdot \vec{C} = M$$

سازگار است و جهت هم دارد



جهت بردار

برای بردار A و B در صفحه آن بردار موازی با بردار C



هم‌جهت بردار

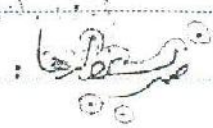
$$\hat{u}_a = \frac{\vec{a}}{|\vec{a}|} \quad \text{بردار یکه}$$

$$\vec{A} = A_x \hat{i} + A_y \hat{j} = |A|(\cos\theta \hat{i} + \sin\theta \hat{j})$$

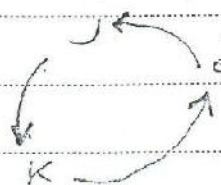
$\cos\theta = \frac{A_x}{|A|}$ و $\sin\theta = \frac{A_y}{|A|}$

$$\vec{A} \cdot \vec{E}$$

$$\vec{A} \times \vec{B}$$



$$\cos\theta = \frac{\vec{A} \cdot \vec{B}}{|\vec{A}||\vec{B}|}$$



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برای ضرب برداری $\vec{A} \times \vec{B}$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \dots$$

برای ضرب برداری $\vec{A} \cdot \vec{B} \times \vec{C}$

$$\begin{vmatrix} A_x & A_y & A_z \\ B_x & B_y & B_z \\ C_x & C_y & C_z \end{vmatrix}$$

برای ضرب برداری $(\vec{A} \times \vec{B}) \times \vec{C}$

$$= - (C \cdot B) \vec{A} + (C \cdot A) \vec{B}$$

AB

$$\frac{d\vec{A}}{dt} = \frac{dA_x}{dt} \hat{i} + \frac{dA_y}{dt} \hat{j} + \frac{dA_z}{dt} \hat{k} + A_x \frac{d\hat{i}}{dt} + A_y \frac{d\hat{j}}{dt} + A_z \frac{d\hat{k}}{dt}$$

$$\int \vec{A} dt = \int |\vec{A}| \hat{u}_A dt + \int (A_x \hat{i} + A_y \hat{j} + A_z \hat{k}) dt = \int A_x dt \hat{i} + \dots$$

$$\vec{F} = -\vec{\nabla}\phi = -\frac{\partial\phi}{\partial x} \hat{i} - \frac{\partial\phi}{\partial y} \hat{j} - \frac{\partial\phi}{\partial z} \hat{k}$$

برای ضرب برداری
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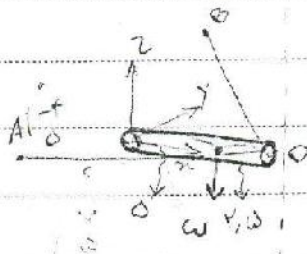
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(موضوع: مهندسی مکانیک و مقاومت مصالح)

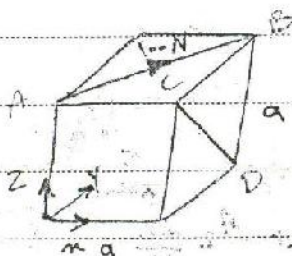


$$|\vec{T}_{AD}| = L \cdot k \cdot u$$

$$\vec{T}_{DA} = |\vec{T}_{AD}| \hat{u}_{DA}$$

نقطه A و D

$$\hat{u}_{DA} = \frac{(x_A - x_D)\hat{i} + (y_A - y_D)\hat{j} + (z_A - z_D)\hat{k}}{\sqrt{(x_A - x_D)^2 + \dots + (z_A - z_D)^2}}$$



F · CD

$$\vec{F} = \frac{F}{\sqrt{a^2 + b^2 + c^2}} (\hat{i} + \hat{j} + \hat{k})$$

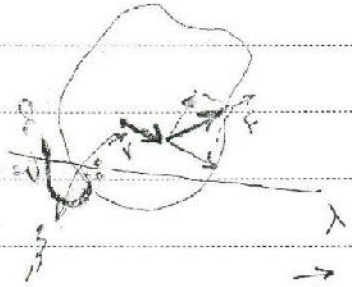
$$\vec{CD} = -\frac{a}{\sqrt{a^2 + b^2 + c^2}} \hat{j} - \frac{b}{\sqrt{a^2 + b^2 + c^2}} \hat{k}$$

کتابچه کوشش / اثر دوران حول نقطه محور / فصل اثر مجموع نیروها

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 Year: _____ Month: _____ Date: _____

$$M = r \times F \rightarrow |M| = r F \sin \theta$$
 (where θ is the angle between r and F)

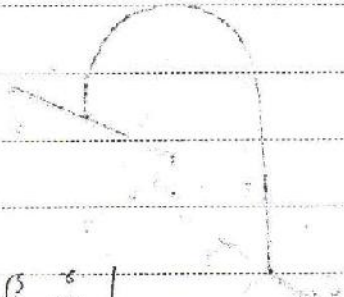
اگر دو نیرو حول یک محور برابر مجموع گشتاورها در جهت دورانی باشد



$$F = F_1 + F_2$$

$$M = r \times F$$

$$M = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$



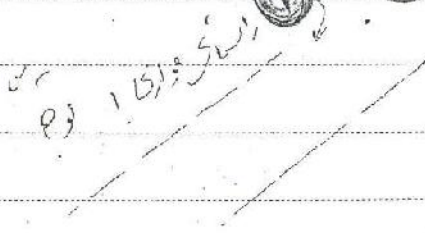
گشتاور

$$M_x = -y F_z + z F_y$$

$$M_x = (r \times F) \cdot U_x$$

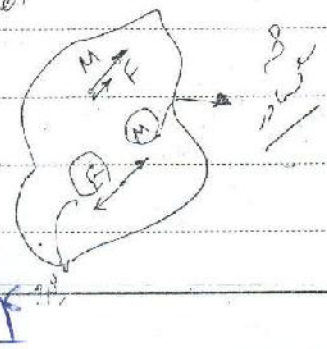


گشتاور (Static) Free vector



اگر دو گشتاور در یک خط باشند

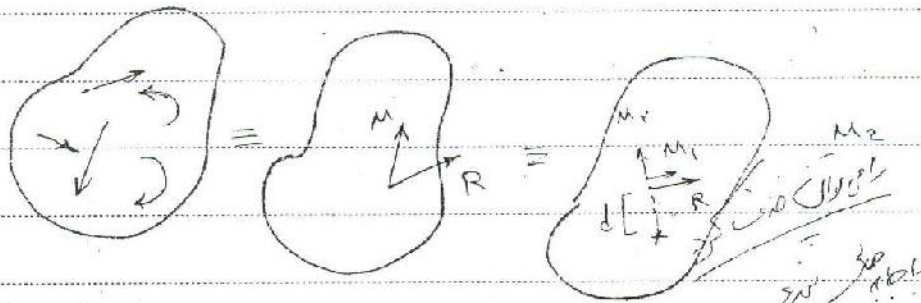
resultant wrench



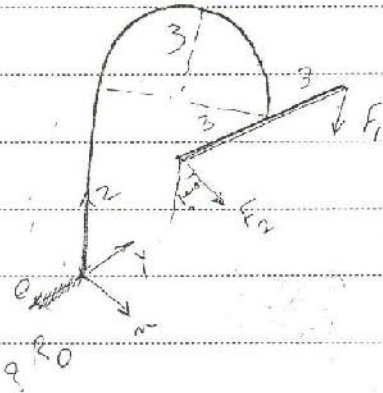
Use

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$$d = \frac{M}{R}$$



$$\vec{F}_1 = -|F_1| \hat{k}$$

$$\vec{F}_1 = |F_1| (\sin \theta \hat{i} - \cos \theta \hat{k})$$

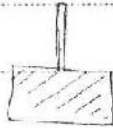
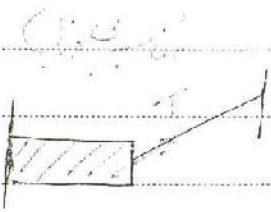
$$\vec{F}_1 + \vec{F}_2 = (|F_1| \sin \theta \hat{i} - (|F_1| + |F_2| \cos \theta) \hat{k})$$

مسئلہ

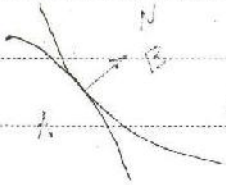
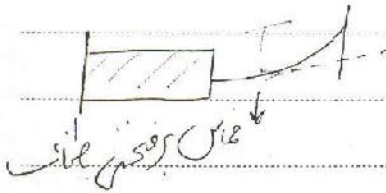
$$M_D = r_A \times F_2 + r_B \times F_1 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 0 \\ |F_1| \sin \theta & 0 & -(|F_1| + |F_2| \cos \theta) \end{vmatrix} = \hat{i} \times 0 - \hat{j} \times 0 + \hat{k} \times 0$$

Subject: _____

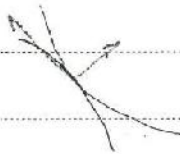
Year: _____ Month: _____ Date: _____ ()



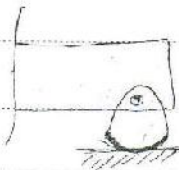
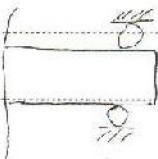
① : $\vec{F} = \vec{F}_1 + \vec{F}_2 + \dots$



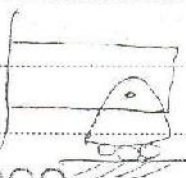
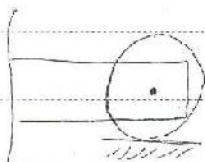
والتension في السطح



MAX. μ



والتension في السطح



Subject:

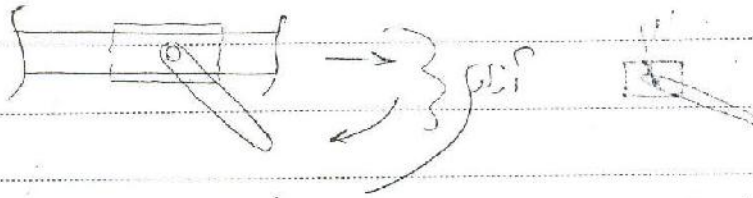
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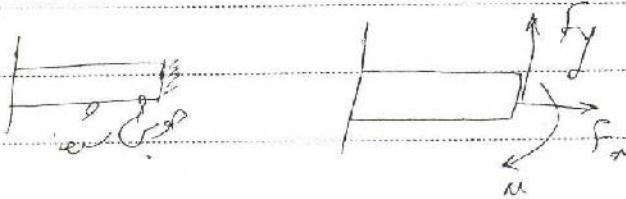
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Pin & bush



clamped & bush



Ball & socket

Ball & socket

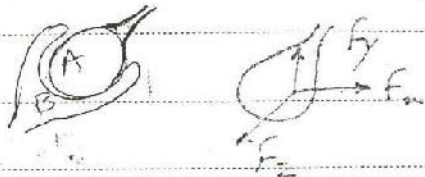


Diagram of a ball and socket joint showing forces Fx, Fy, and Fz. The text 'Degree of freedom' is written above it.

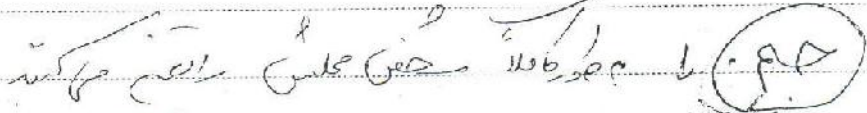


Diagram of a ball and socket joint showing forces Fx, Fy, and Fz.

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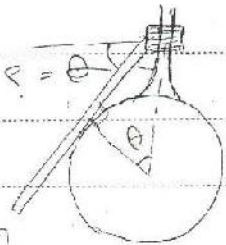
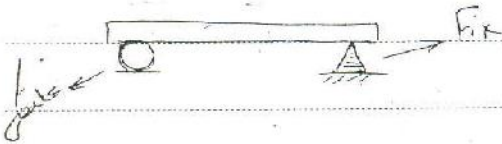
Physics of Levers

و در اینجا

وقتی قدر راد انقدر حرکت از آن طرف برداریم F_a بر اثر آن

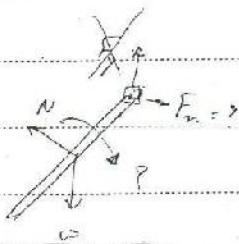
" " F_b ← " " " " " "

" " " " " " " " " " " "



$$\tan \theta = \frac{x}{r}$$

$$n = r \tan \theta$$



مال: P

$$N, F_f, \theta = \frac{P}{\cos \theta}$$

P = ...

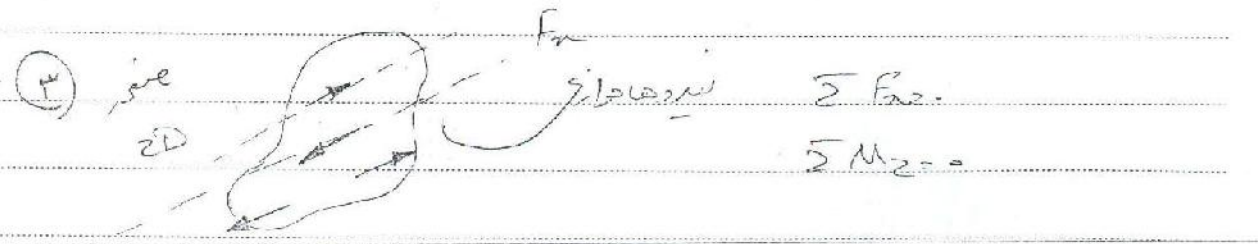
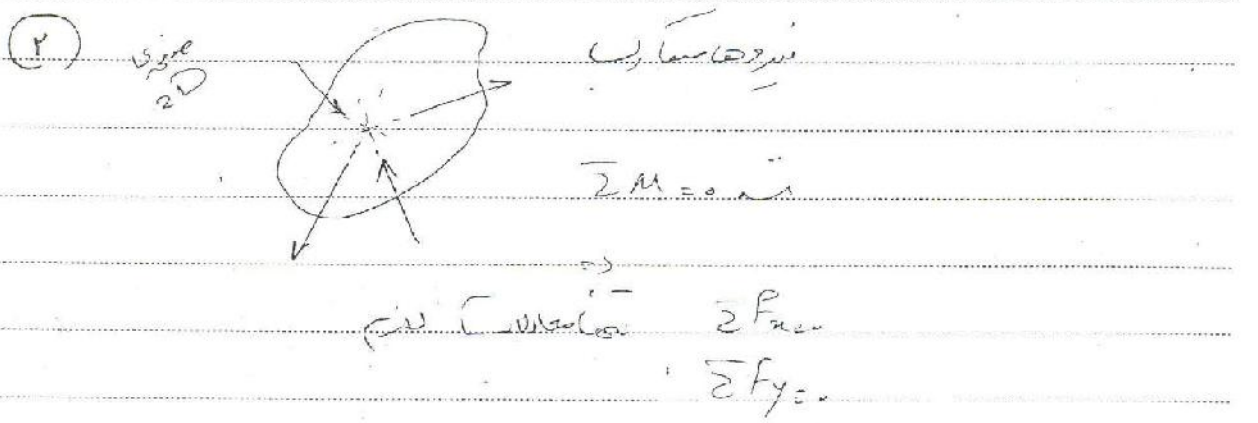
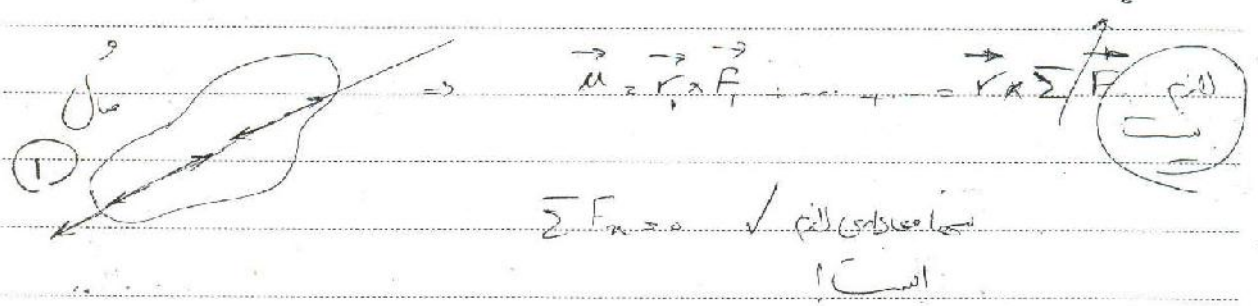
سخت در بردار از اولی غیر بردار حول چه نقطه ای حساب می کنیم ؟

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: notice ←

$\sum \vec{M} = 0$ / $\sum \vec{F} = 0$ مطلوبه برای تعادل داشتن (معادل استاتیکی)
نقطه P را انتخاب می کنیم

$\sum F_{x0} = 0$ $\sum M_2 = 0$
 $\sum F_{y0} = 0$ $\sum M_{y0} = 0$
 $\sum F_{z0} = 0$ $\sum M_z = 0$



Subject:

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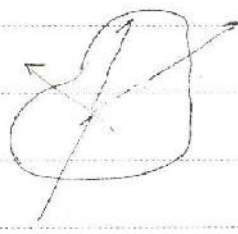
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برای ۲ و ۳ = دو کلمه ۳ جمله
برای ۱ = ۲ جمله ۳ کلمه

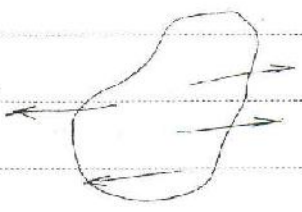
④ 3D
نیروی موازی
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$$\sum F_x = 0$$
$$\sum F_y = 0$$
$$\sum F_z = 0$$

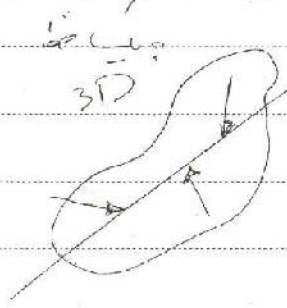
3D

⑤ نیروهای موازی



$$\sum F_x = 0$$
$$\sum M_y = 0$$
$$\sum M_z = 0$$

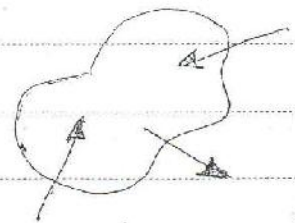
⑥ نیروهای موازی



$$\sum F_x = 0$$
$$\sum M_y = 0$$
$$\sum F_y = 0$$
$$\sum M_z = 0$$
$$\sum F_z = 0$$
$$\sum M_x = 0$$

⑦ 2D

کروی



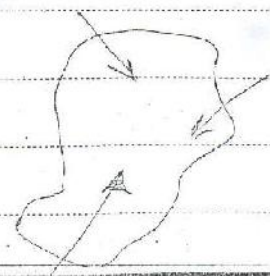
$$\sum F_x = 0$$
$$\sum F_y = 0$$
$$\sum M_z = 0$$

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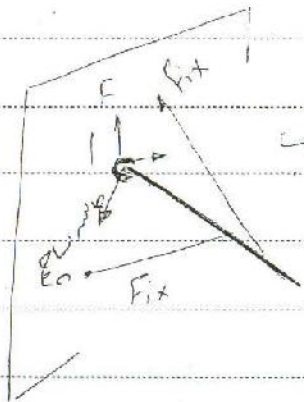
نیروی موازی

نیروی موازی

3D
کروی



۵-۶-۷-۸-۹-۱۰-۱۱-۱۲-۱۳-۱۴-۱۵-۱۶-۱۷-۱۸-۱۹-۲۰-۲۱-۲۲-۲۳-۲۴-۲۵-۲۶-۲۷-۲۸-۲۹-۳۰-۳۱-۳۲-۳۳-۳۴-۳۵-۳۶-۳۷-۳۸-۳۹-۴۰-۴۱-۴۲-۴۳-۴۴-۴۵-۴۶-۴۷-۴۸-۴۹-۵۰-۵۱-۵۲-۵۳-۵۴-۵۵-۵۶-۵۷-۵۸-۵۹-۶۰-۶۱-۶۲-۶۳-۶۴-۶۵-۶۶-۶۷-۶۸-۶۹-۷۰-۷۱-۷۲-۷۳-۷۴-۷۵-۷۶-۷۷-۷۸-۷۹-۸۰-۸۱-۸۲-۸۳-۸۴-۸۵-۸۶-۸۷-۸۸-۸۹-۹۰-۹۱-۹۲-۹۳-۹۴-۹۵-۹۶-۹۷-۹۸-۹۹-۱۰۰-



درجه های سفتی
 $3 \times 3 = 9$

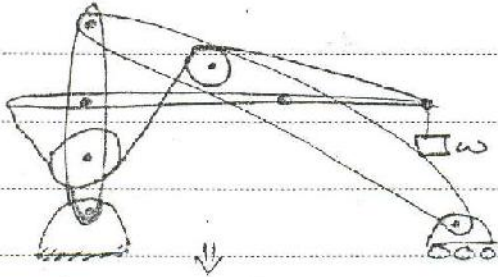
الترتیب جانب درجه های سفتی

مجهول در معادله !!!

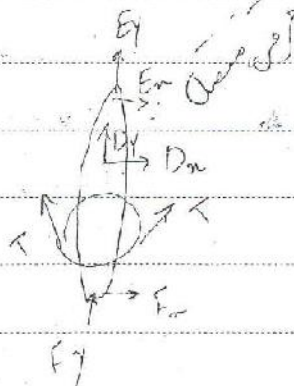
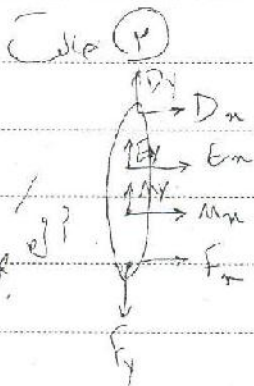
(statically indeterminate)

الترتیب جانب درجه های سفتی !!!

فاصله ها و کدرها را در نظر بگیرید یا محبت کنیم این را!



درجه های سفتی را در نظر بگیرید
 و این را هم در نظر بگیرید!

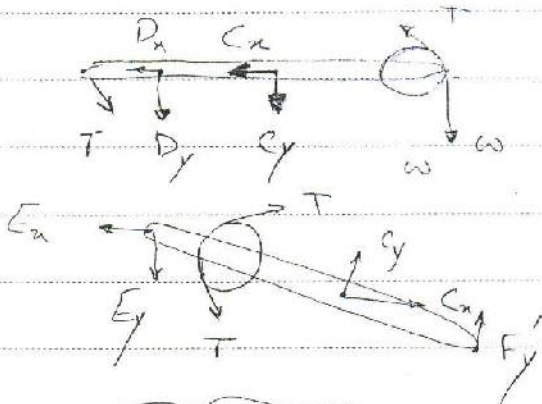


(A)

(V)

حل کردن است

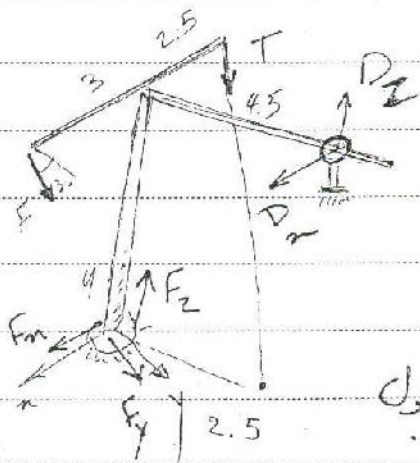
۵۰ اجزا را بر مبنای این رسم رسم کنید.



۱) معنی است مسائل از نظر داخلی یعنی از دیدگاه مخرج است! و این را در مخرج

از سمت راست به سمت چپ هر دو طرف را نیز علامت

از طرفین



۱) جهت از محلات تمام و شروع کنیم

۲) گمان در اصول تمام از طریق که بر مبنای اصول

انزال می کنند!

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$$\sum \vec{F}_{oo}$$

$$\sum \vec{M}_{oo} \rightarrow \sum M_{oo} = \begin{array}{c|c|c} i & j & k \\ \hline 6 & 0 & 0 \\ \hline -6 & -5 & +4 \end{array} + \begin{array}{c|c|c} i & j & k \\ \hline 4 & 0 & 0 \\ \hline 0 & 0 & 0 \end{array} + \begin{array}{c|c|c} i & j & k \\ \hline 0 & 0 & 0 \\ \hline 0 & 0 & 0 \end{array} + \begin{array}{c|c|c} i & j & k \\ \hline 0 & 0 & 0 \\ \hline 0 & 0 & 0 \end{array}$$

$$+ \begin{array}{c|c|c} i & j & k \\ \hline 3 & 0 & -2 \\ \hline \end{array} = 0$$

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$$\vec{\Sigma F} = 0$$

$$\vec{\Sigma M} = 0 \rightarrow \Sigma M_x = 0$$

$$\frac{|T_1|}{\sqrt{27}} \begin{vmatrix} i & j & k \\ 6 & 0 & 0 \\ -6 & -5 & +6 \end{vmatrix} + \frac{|T_2|}{\sqrt{41}} \begin{vmatrix} i & j & k \\ 4 & 0 & 0 \\ -4 & 4 & 3 \end{vmatrix} = 0$$

$$C_y \begin{vmatrix} i & j & k \\ 0 & 0 & -4 \\ 0 & 1 & 0 \end{vmatrix} + W \begin{vmatrix} i & j & k \\ 3 & 0 & -2 \\ 0 & 0 & -1 \end{vmatrix} = 0$$

$$\vec{r}_1 \times \vec{T}_1 = 0$$

$$\vec{r}_2 \times \vec{T}_2 = 0$$

$$\vec{r}_3 \times \vec{T}_3 = 0$$

$$\vec{r}_4 \times \vec{W} = 0$$

کتاب = الفیاض فی المکانیک

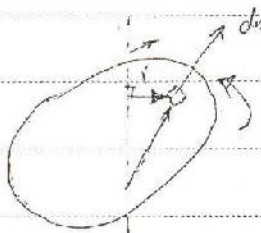
نقطه ذره ای خود را ρ پس از نظر پاره ای و اصول حرکت در یک جسم چوله (شکل) قرار دهد

(مورد معروف) خطایابی در حرکت چرخشی (مکانیک) است.

تویان من بعد برای برداشتن برداشته می شود و از برای لحاظ برداشته می شود ρ و ρ را می توان

این است که ρ چیست؟ این به هم می خورد و حاصل برداشتن ρ را می توان

برای یک محور دور خود (محور) ρ خطا از این جهت است که



این جهت به ρ محور دور است

حالاتی است که با هم جلا می آید در جهت تعادل در یک

① هم در نقاط (این است) که در جهت تعادل است ρ هر خطی که از مرکز دور است ρ

$$\sum \vec{r} = 0$$

② اگر محور را برانیم می توانیم آنرا عمل می بینیم ρ و ρ را می توانیم ρ را

محور استکانیم و این ρ را می توانیم برداشتن ρ را می توانیم برداشتن ρ را

$$\left\{ \begin{array}{l} \sum M_x \\ \sum M_y \\ \sum M_z \end{array} \right. = 0$$

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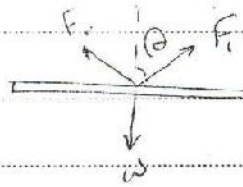
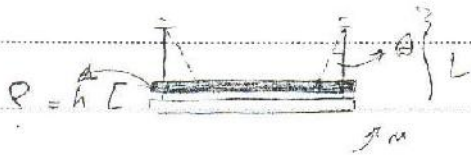
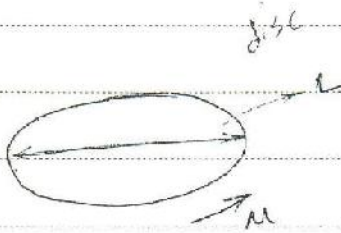


سچے کلمے دکھوانے کے لیے یہ رسم لکھیں



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$$\begin{cases} 2F_1 \cos \theta = W \\ 2F_1 r \sin \theta = M \\ r = \frac{L}{2} \end{cases}$$

$$\left(\sin \theta \text{ or } \sin \theta = \frac{M}{W r} \right)$$

$$h = \left(\frac{1}{2} W \cos \theta \right) \left(\frac{L}{2} \right) \left(\frac{1}{\sin \theta} \right)$$

$$h = \frac{M}{W r} \left(\frac{1}{2} W \right) \left(\frac{L}{2} \right) \left(\frac{1}{\sin \theta} \right)$$

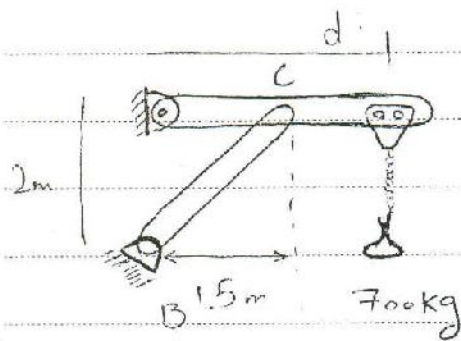
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Date.

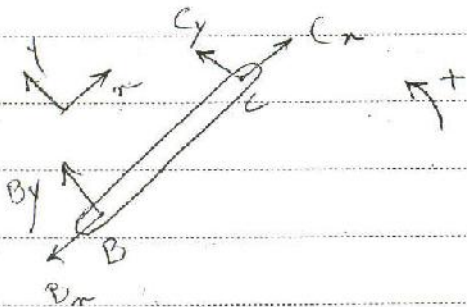
()



PA, 2006 nd J... BC, new 5, m

1.7m < d < 3.5m

θ



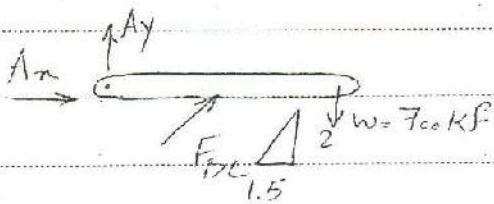
$$\sum M_B = 0 \Rightarrow |BC| \cdot C_y = 0$$

$$\Rightarrow C_y = 0$$

$$\sum F_y = 0 \Rightarrow B_y + C_y = 0$$

$$\Rightarrow B_y = 0$$

$$\sum F_x = 0 \Rightarrow B_x + C_x = 0 \Rightarrow B_x = -C_x$$



$$\sum M_A = 0 \Rightarrow 1.5 \cdot F_{BC} \cdot \frac{4}{5} - d \times 700 = 0$$

$$F_{BC} = (5.72 d) \text{ KN}$$

$$\sum F_x = 0 \Rightarrow A_x + \frac{3}{5} F_{BC} = 0$$

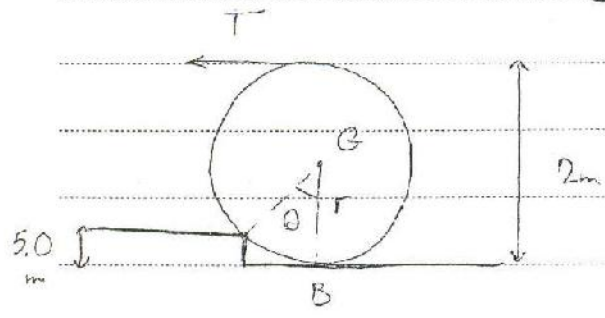
$$\Rightarrow A_x = -3.43 d \text{ KN}$$

$$\sum F_y = 0 \Rightarrow A_y + \frac{4}{5} F_{BC} - (700 \times 3.5) = 0$$

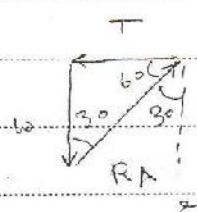
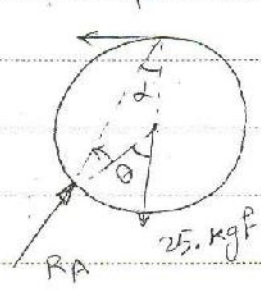
Subject:

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یک سوزن استوانه‌ای ۲۵ کیلوگرمی از یک نخ به ارتفاع ۰.۵ متری
 بلند نگه داشته شده و دور سوزن یک نخ دیگر در یک زاویه ۳۰ درجه کشیده شده
 به ازای آن نخ دیگری A در عمق ۰.۵ متر است



- ۱) کشش نخ را حساب کنید
 ۲) عکس العمل در نقطه B را حساب کنید



$W = R_A \cos 30^\circ \Rightarrow R_A = 2832 \text{ N}$
 $T = R_A \sin 30^\circ \Rightarrow T = 1416 \text{ N}$

حل: ما سوزن را در حالت تعادل می‌بینیم. بردار عکس العمل را به ارتفاع ۰.۵ متر
 از چپ اعمال می‌کنیم.

۳ نیروی موازی عکس العمل A
 کشش نخ CD
 عکس العمل B

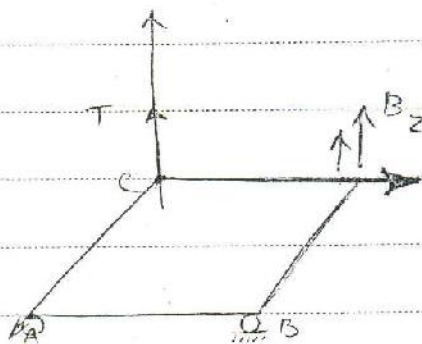
Subject _____

Year _____

Month _____

Date _____

() _____



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ماتریک کی درسیں 2 (پہلی اور دوسری) کے لیے ریاضی کے مسائل حل کرنے کے لیے

معارف کے مسائل

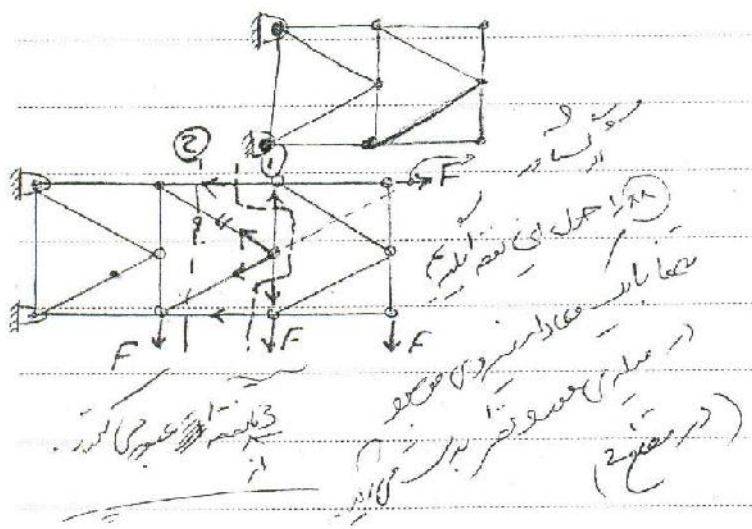
استعداد در ... تا ... وضع ... از ... بطنه ... در ... توان

Subject: Year: Month: Date: ()

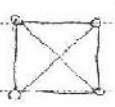
در ... وضع ... : ...

در ...

مال



در ...



در ...

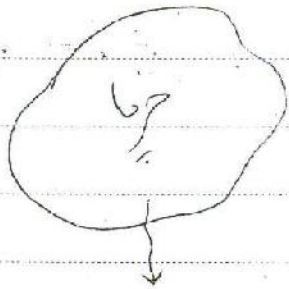


در ...

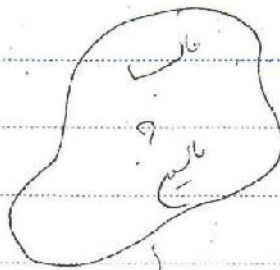
Subject:

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Bar: میله
Beams: تیر



عضو دیرین

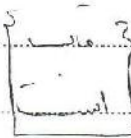
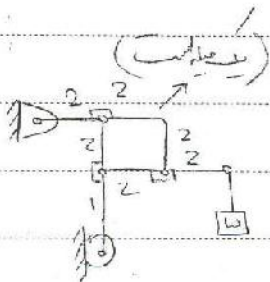


عضو دیرین

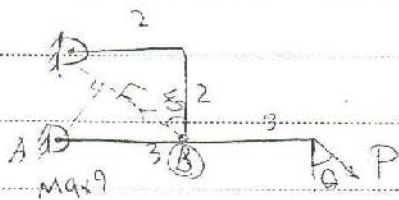
تا چند صافی

درجه آزادی ماشین

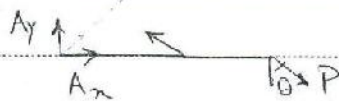
مثال ۳



این تیر در حالت ...
است که ...



$$-\frac{\pi}{2} < \theta < \frac{\pi}{2}$$



$$\sum F_{x=0} = P \sin \theta - F \frac{x}{4} + A_{x2} = 0$$

$$\sum F_y = 0 \Rightarrow A_y + F \frac{x}{4} - P \cos \theta = 0$$

$$\sum M = 0 \Rightarrow F \times 3 \times \frac{x}{4} - P \cos \theta \times 4 = 0$$

$$F = 2/3 P \cos \theta$$

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$$P \sin \theta - 2P \cos \theta + A_x = 0$$

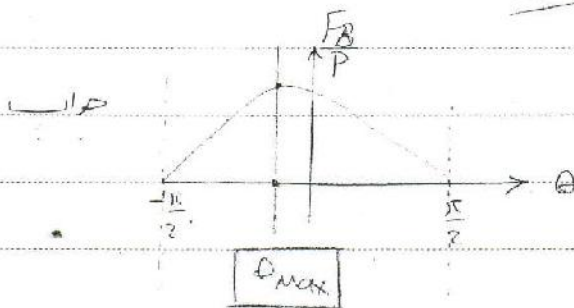
$$A_y + 2P \cos \theta - P \sin \theta = 0$$

$$\Rightarrow A_y = P \sin \theta$$

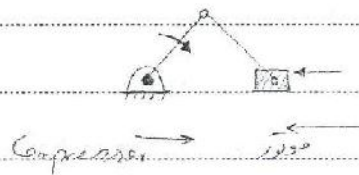
$$\Rightarrow A_x = 2P \cos \theta - P \sin \theta$$

$$A_{\text{max}} = \sqrt{A_x^2 + A_y^2} = \sqrt{(2P \cos \theta - P \sin \theta)^2 + (P \sin \theta)^2}$$

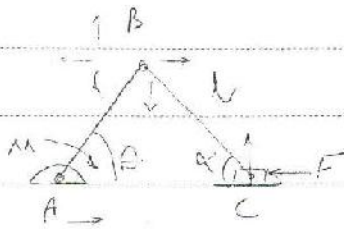
$$\rightarrow \frac{d}{d\theta} = 0$$



Machines:



Examples:



$$\left(\begin{array}{l} \text{Clockwise} \\ \text{BC} \end{array} \right) \oplus$$

$$\sum F_x = 0 \Rightarrow F + B \cos \alpha = 0$$

$$\sum F_y = 0 \Rightarrow N - B \sin \alpha = 0$$

$$\sum M = 0$$

$$B \sin \alpha \cdot L \cos \theta - L \sin \alpha \cdot B = 0$$

$$\left. \begin{array}{l} -B \cos \alpha + A_x = 0 \\ B \sin \alpha + A_y = 0 \end{array} \right\}$$

$$-M + B \sin \alpha \cdot L \cos \theta + B \sin \alpha \cdot L = 0$$

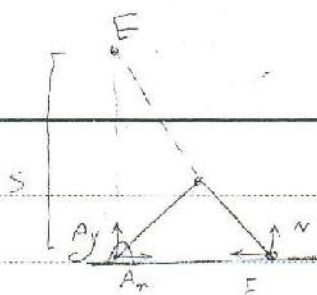
$$\frac{r}{\sin \alpha} = \frac{L}{\sin \theta}$$

$$M = F_r [\sin \theta + \cos \theta \tan \alpha]$$

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المطلوب:



$$\sum F_x = 0 \Rightarrow F = A_x$$

$$\sum M_E = 0$$

$$-M + A_x S = 0$$

$$\Rightarrow \boxed{M = FS}$$

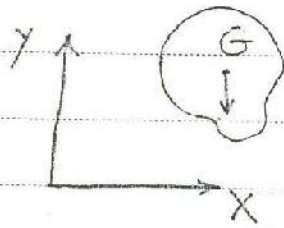
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Distributed load

بارهای گسترده

وزن مرکز جرم
وزن مرکز جرم



$$\vec{CG} = X_0 \hat{i} + Y_0 \hat{j} + Z_0 \hat{k}$$

$$X_0 = \frac{\int g x dm}{\int g dm}$$

$$Y_0 = \frac{\int g y dm}{\int g dm}$$

$$Z_0 = \frac{\int g z dm}{\int g dm}$$

$g = \text{const.}$ $X_0 = \frac{\int x dm}{\int dm}$ $Y_0 = \frac{\int y dm}{\int dm}$ $Z_0 = \frac{\int z dm}{\int dm}$

$$Y_0 = \frac{\int y dm}{\int dm}$$

$$Z_0 = \frac{\int z dm}{\int dm}$$

$$\frac{\int x dv}{\int dv}, \frac{\int y dv}{\int dv}, \frac{\int z dv}{\int dv}$$

$$dv = t \cdot dA \Rightarrow \frac{\int x t dA}{\int t dA}$$

$$dA = b \cdot dt \Rightarrow \frac{\int x b dt}{\int b dt}$$

KANDOO

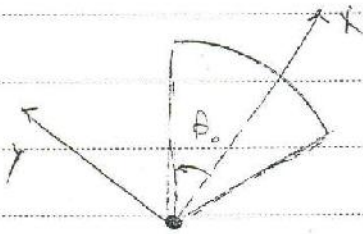
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مثال ۸

نقطه مرکز جرم موربایان دایره به مرکز

روی موربایان است (یعنی موربایان = حرکت روی محل و پلاست)



$\bar{y} = 0$

① موربایان را به دست آوریم

$$C.G. \int x dm = \frac{\int R^2 \lambda \cos \theta d\theta}{\int \lambda R d\theta} = \frac{2R^2 \lambda \sin(\theta_0)}{2\lambda R \theta_0} = \frac{R \sin(\theta_0)}{\theta_0}$$

$dm = \lambda dL = \lambda R d\theta$

$dL = R d\theta$

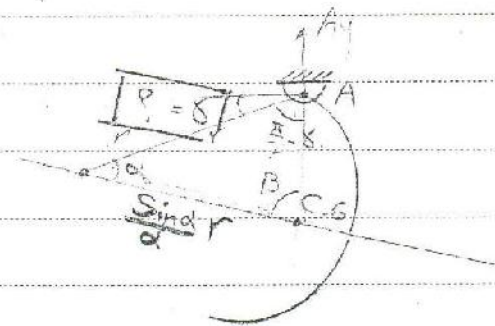
$x = R \cos \theta$

$\theta_0 \rightarrow 0 \quad \bar{x} = R$

$\theta_0 \rightarrow \frac{\pi}{4} \quad \bar{x} = \frac{2\sqrt{2}}{\pi} R$

$\theta_0 \rightarrow \frac{\pi}{2} \quad \bar{x} = \frac{2}{\pi} R$

$\theta_0 \rightarrow \pi \quad \bar{x} = 0$



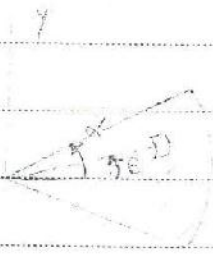
$\Rightarrow \sin \beta = \frac{\sin \alpha \cdot h}{b}$

$\beta = \pi - (\frac{\pi}{2} - \alpha + \alpha)$

مثال ۹

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$$\bar{x} = \frac{\int x dA}{\int dA} = \frac{\int_0^{\alpha} \int_0^R r \cos \theta (r dr) d\theta}{\int_0^{\alpha} \int_0^R r dr d\theta}$$

$$dA = r dr d\theta$$

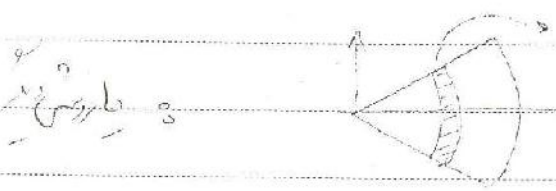
$$\frac{2 \cdot \frac{1}{2} R^2 \sin \alpha}{2 \cdot \frac{1}{2} R^2 \alpha} = \frac{2}{3} \frac{\sin \alpha}{\alpha} R$$

① $\alpha \rightarrow 0 \quad \bar{x} = \frac{2}{3} R \quad ? \rightarrow$ *Ex: ...*

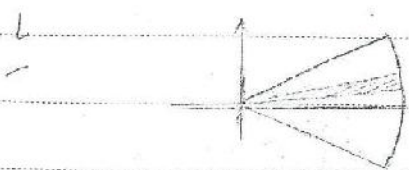
② $\alpha \rightarrow \frac{\pi}{4} \quad \bar{x} = \frac{4\sqrt{2}}{3} R$

③ $\alpha \rightarrow \frac{\pi}{2} \quad \bar{x} = \frac{4R}{3}$

④ $\alpha \rightarrow \pi \quad \bar{x} = 0$



$$\frac{\int x dA}{\int dA} = \frac{\int_0^R \frac{2 \sin r}{\alpha} r^2 dr}{\int_0^R r^2 dr} = \dots$$



$$dA = \frac{(R d\theta) R}{2} = \frac{R^2}{2} d\theta$$

$$x = \frac{2}{3} R$$

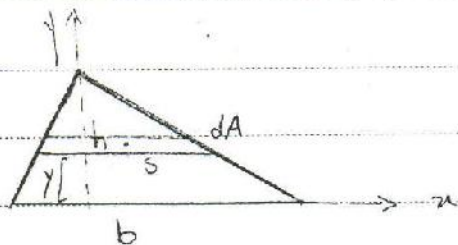
$$\rightarrow \int \frac{2}{3} R \frac{d\theta \cos \theta}{2} =$$

KANDOO

IV

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P. 200/30

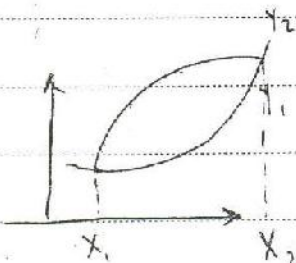
$$\bar{y} = \frac{\int y dA}{\int dA}$$

$$\frac{s}{b} = \frac{h-y}{h} \Rightarrow s = \frac{b}{h}(h-y)$$

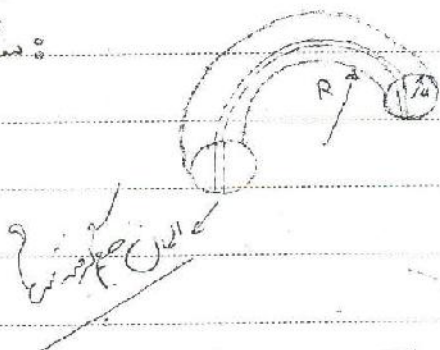
$$s dy = dA \Rightarrow dA = \frac{b}{h}(h-y) dy$$

$$\bar{x} = \frac{\int x dA}{\int dA}$$

$$\rightarrow \bar{y} = \frac{\frac{b}{h} \int_0^h y(h-y) dy}{\frac{b}{h} \int_0^h (h-y) dy} = \frac{\frac{1}{2} h^2 - \frac{1}{3} h^3}{h^2 - \frac{1}{2} h^2} = \frac{h^2 \left(\frac{1}{2} - \frac{1}{3} \right)}{h^2 \left(1 - \frac{1}{2} \right)} = \frac{1}{3} h$$



سوال 5:



$$\bar{x} = 0$$

$$\bar{y} = 0$$

$$\bar{z} = 0 \quad R + a$$

$$\bar{y} = \frac{\int y dv}{\int dv} = \frac{\int_{R-a}^{R+a} \frac{2r}{\pi} (\pi r) (dr) (2b)}{\int_{R-a}^{R+a} \pi r^2 (dr) 2b}$$

$$2 \int_{R-a}^{R+a} \sqrt{a^2 - (R-r)^2} dr$$

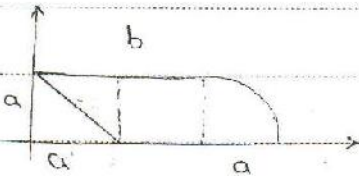
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جواب سوال (۱) : $\frac{4R^2 + a^2}{2R}$

if $a \rightarrow \frac{2R}{\sqrt{2}}$ ✓

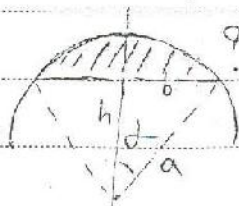
(۱) ← در حالت کلی : هم پاره کنی انت از حد جسم بدو!



ردیف	A_i	X_i	Y_i	$X_i A_i$	$Y_i A_i$
1 مثلث	$+ab$	$\frac{b}{2}$	$\frac{a}{2}$	$\frac{ab^2}{2}$	$\frac{ba^2}{2}$
2 مستطین	$-\frac{a^2}{2}$	$+\frac{a}{3}$	$+\frac{a}{3}$	$-\frac{a^3}{3}$	$-\frac{a^3}{3}$
3 ربع دایره	$\frac{2}{3}a^2$	$b + \frac{2a}{3}$	$\frac{2a}{3}$	$(b + \frac{2a}{3}) \cdot \frac{2a^2}{3}$	$\frac{2a}{3} \times \frac{2}{3}a^2$

$$\bar{X} = \frac{\sum X_i A_i}{\sum A_i}$$

$$\bar{Y} = \frac{\sum Y_i A_i}{\sum A_i}$$



(۲)

$$\bar{Y} = \frac{\sum Y_i A_i}{\sum A_i} = \frac{\sum Y_i A_i}{\sum A_i}$$

$$2a \cdot \frac{2a}{3} \frac{\sin \alpha}{\alpha} - hb \frac{2}{3}$$

$$2a^2 - hb$$

KANDOO $h = \sqrt{a^2 - b^2}$

Subject: _____

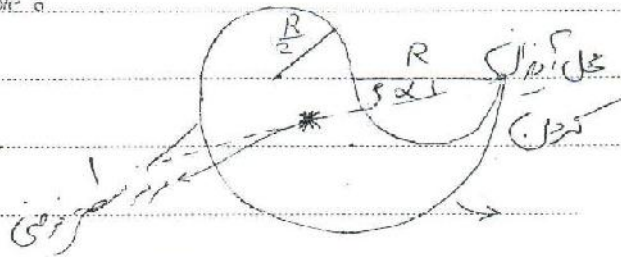
Year: _____

Month: _____

Date: _____

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* Exam Suitable :



→ ()

$$\bar{x} = \frac{\frac{\pi}{2} R^2 (0) + \frac{\pi R^2}{2 \cdot 4} \left(-\frac{R}{2}\right) - \frac{\pi R^2}{2 \cdot 4} \left(\frac{R}{2}\right)}{\frac{\pi R^2}{2} + \frac{\pi R^2}{2 \cdot 4} + \frac{\pi R^2}{2 \cdot 4}}$$

$$\Rightarrow \bar{x} = \frac{-\frac{\pi R^2}{4} \left(\frac{R}{2}\right)}{\frac{\pi R^2}{2}} = -\frac{R}{4} = -\frac{R}{4}$$

$$\bar{y} = \frac{\frac{\pi}{2} R^2 \left(-\frac{2R}{\pi}\right) + \frac{\pi R^2}{2 \cdot 4} \left(\frac{2R}{\pi}\right) - \frac{\pi R^2}{2 \cdot 4} \left(-\frac{2R}{\pi}\right)}{1}$$

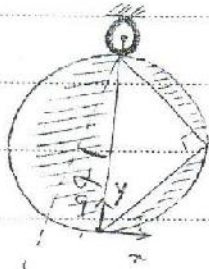
$$= \frac{\frac{\pi R^2}{2} \left(-\frac{2R}{\pi}\right) + \frac{\pi R^2}{2 \cdot 4} \left(\frac{2R}{\pi}\right) - \frac{\pi R^2}{2 \cdot 4} \left(-\frac{2R}{\pi}\right)}{1} = \frac{-3}{2\pi} R \times \frac{2}{3} = -\frac{R}{\pi}$$

$$\tan \alpha = \frac{|\bar{y}|}{R + |\bar{x}|}$$

Subject:

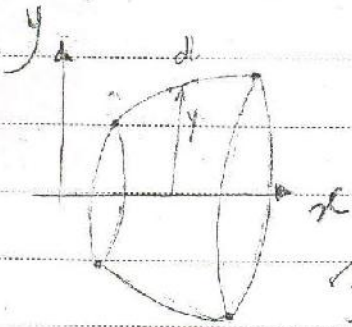
Year. Month. Date. ()

مساحة سطح كروي



مساحة سطح كروي

مساحة سطح كروي
Parabola



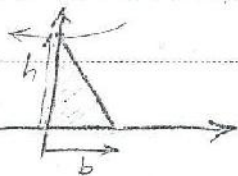
$$A = \int 2\pi y \, dl = 2\pi \int y \, dl = 2\pi \bar{y} L$$

مساحة سطح كروي

$$V = \int 2\pi y \, dA = 2\pi \int y \, dA = 2\pi \bar{y} A$$

مساحة سطح كروي

مساحة سطح كروي



$$A = \int 2\pi x \, dl = 2\pi \bar{x} L$$

$$\bar{x} = \frac{b}{2}$$

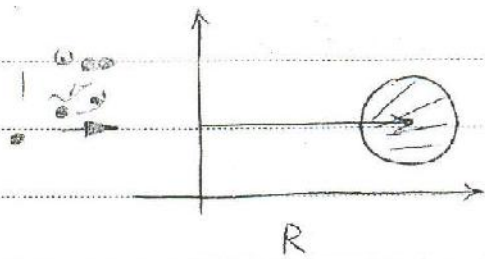
$$2\pi \left(\frac{b}{2}\right) L = \pi b L$$

$$V = 2\pi \bar{x} A = \frac{2\pi b}{3} \times \frac{bb}{2} = \frac{\pi b^2 h}{3}$$

مساحة سطح كروي

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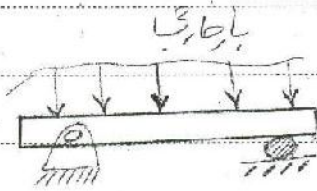
$A = \pi R^2$

$V = A \bar{x} A$

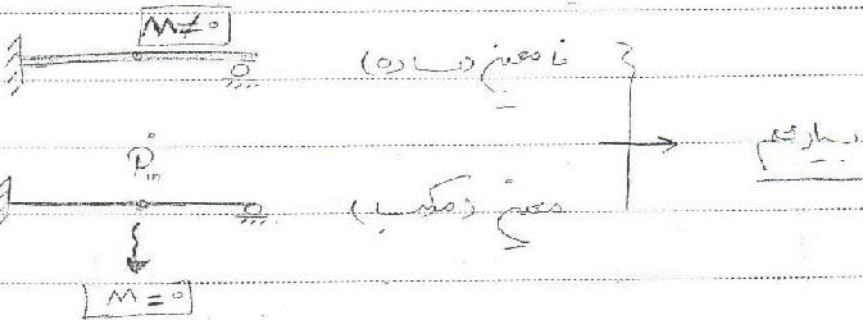
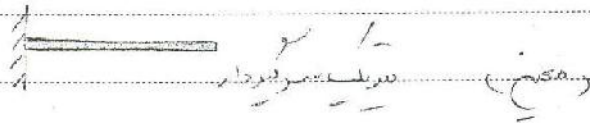
$\pi R^2 (\pi R^2) = \frac{\pi^2 R^4}{4}$

Beam: سیر

فرق با عمده
 2 عضو 2 سیر
 2 سیر عضو 2 سیر



این سیر یک سیر است!
 در آن بار یکنواخت 2 سیر است!



simply supported (Pinned) (S) (SS)



(Fixed) (F)

Subject:

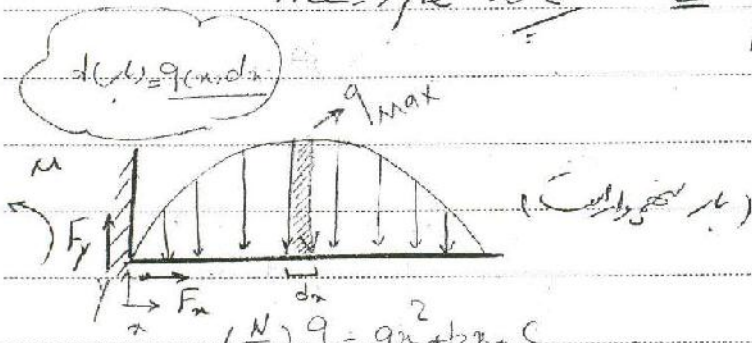
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① کسی بھی صورت میں
 ② کسی بھی صورت میں

!! ←

$$\triangle \equiv \begin{matrix} \infty \\ | \\ \infty \\ \infty \end{matrix}$$

Free style life \equiv مزید جو آئے



$$\left(\frac{N}{m}\right) q = an^2 + bn + c$$

$$q|_0 = 0 \rightarrow c = 0$$

$$q|_L = 0 \rightarrow aL^2 + bL = 0$$

$$q|_{\frac{L}{2}} = 0 \rightarrow \text{Condition satisfied!}$$

$$\rightarrow a = -\frac{4q_0}{L^2}, \quad b = \frac{4q_0}{L}$$

$$q = \frac{q_0}{L} \left(-\frac{4}{L}x + \frac{4}{L} \right) x = -\frac{4q_0}{L^2} (x-L)x \quad \checkmark$$

$$\sum F_x = 0 \Rightarrow F_x = 0$$

$$\sum F_y = 0 \Rightarrow F_y - \int_0^L q dx = 0 \Rightarrow F_y = \int_0^L q dx$$

$$\sum M = 0 \Rightarrow M - \int_0^L q x dx = 0$$

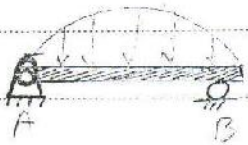
$$M = \int_0^L q x dx$$

$$KANDOO \quad F_y = \int_0^L -\frac{4q_0}{L^2} (x-L)x dx \quad M = \int_0^L \frac{-4q_0}{L^2} (x-L)x^2 dx$$

Yo

Subject:

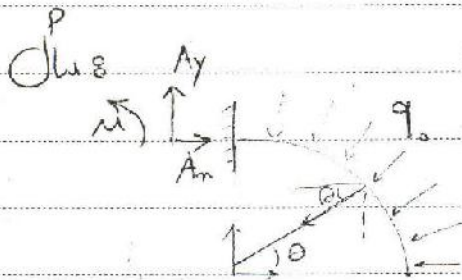
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- ① $\sum F_x = 0$
- ② $\sum F_y = 0 \Rightarrow A_y + B_y - \int q \cos \theta \, ds = 0$
- ③ $\sum M = 0 \Rightarrow B_y(l) - \int q \cos \theta \, ds \cdot \frac{l}{2} = 0$

$$\Rightarrow B_y = \frac{Q}{2}$$

$$\Rightarrow A_y = Q - \frac{Q}{2} = \frac{Q}{2}$$



$$Q_x = \int_0^{\frac{\pi}{2}} q(R) d\theta \cos \theta$$

$$= -Rq \int_0^{\frac{\pi}{2}} \cos \theta \, d\theta$$

$$Q_{yx} = - \int_0^{\frac{\pi}{2}} qR d\theta \sin \theta$$

$$= +Rq(-1) = -Rq$$

$$Q = -Rq \hat{i} - Rq \hat{j}$$

$$\vec{r} \times (-Rq)(\hat{i} + \hat{j}) = \int (qR d\theta) (\hat{i} \cos \theta - \hat{j} \sin \theta) \times (R \cos \theta \hat{i} + R \sin \theta \hat{j})$$

$$\vec{r} = x\hat{i} + y\hat{j}$$

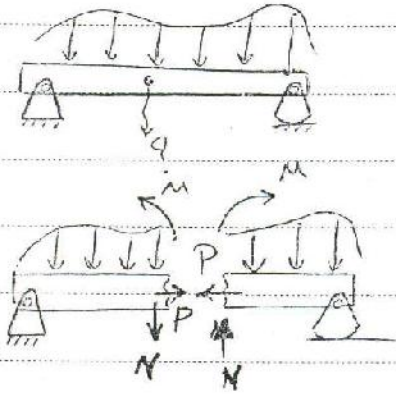
$$= Rq \int (-\sin \theta \cos \theta) \hat{k}$$

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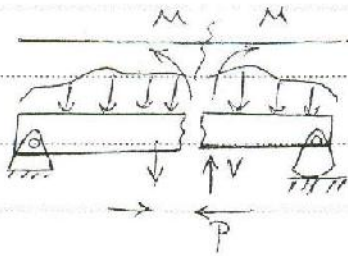
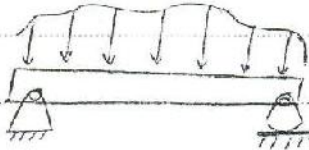
1387 . 2 . 18 ⇒ ستاتیک
static

Today: inner force calculation ...

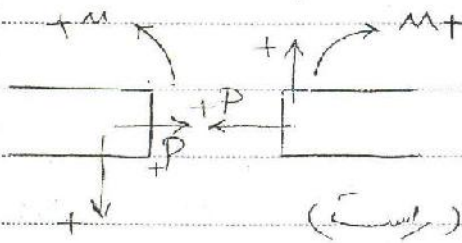


سوال اول

سوال دوم

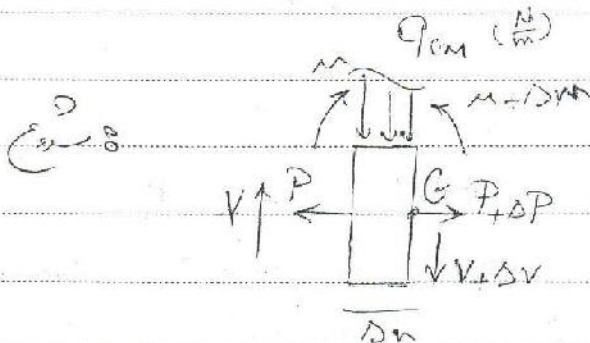
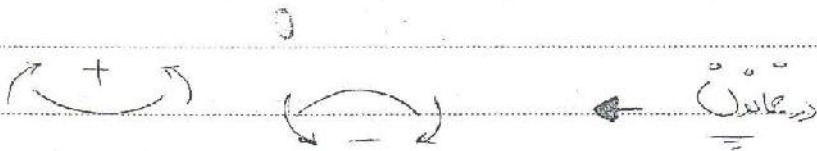


V : نیروی برشی
 P : نیروی کششی
 M : گشتاور



← مقدار زیاد

$(\frac{1}{2} \Delta x)$



$$\sum F_x = 0 \quad (P + \Delta P) - P = 0 \Rightarrow \Delta P = 0$$

$$\sum F_y = 0 \quad - (q(x)) \Delta x + V - (V + \Delta V) = 0$$

$$\Rightarrow \frac{dV}{dx} = -q(x) \quad / \quad V(x) = \int -q(x) dx$$

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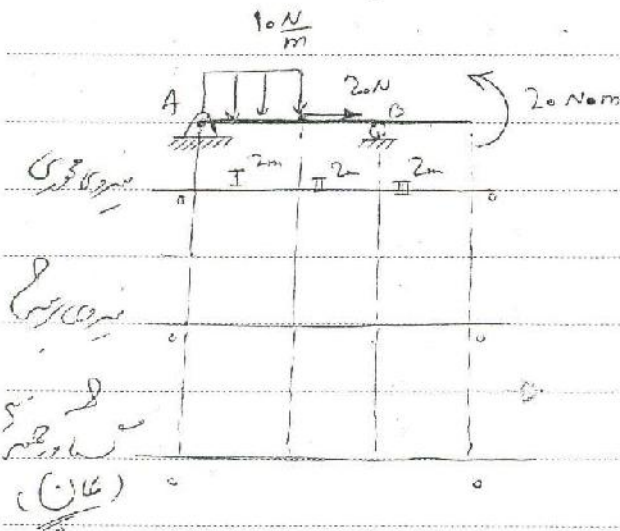
$$\sum M = 0 \quad M + \Delta M - M - V \Delta x + q(x) \Delta x \cdot \frac{\Delta x}{2} = 0$$

$$\Delta M - V \Delta x + \frac{q(x) \Delta x^2}{2} = 0$$

$$\Delta x \rightarrow 0 \Rightarrow \Delta M \rightarrow 0$$

$$\frac{dM}{dx} = V$$

$$\Rightarrow \frac{dM}{dx} = V, \quad \frac{dV}{dx} = -q(x)$$



$$\sum M_A = 0$$

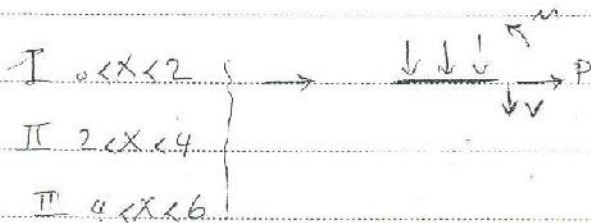
$$20 - \frac{10 \times 4^2}{2} \times 1 + B_y(4) = 0$$

$$B_y = 0 \text{ (N)}$$

$$\sum F_y = 0 \quad A_y - 10 \times 2 = 0 \Rightarrow A_y = 20$$

$$\sum F_x = 0 \rightarrow A_x = -20$$

P
 $\frac{10}{2} \times 4 = 20$?



$$\sum F_x = 0 \quad 20 - 20 + P$$

$$\sum M_B = 0 \quad M + (20)x - 10 \times x \times \frac{x}{2} = 0$$

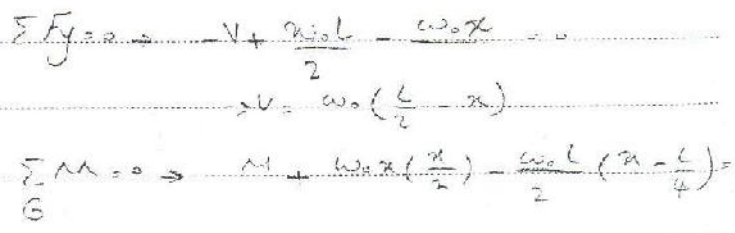
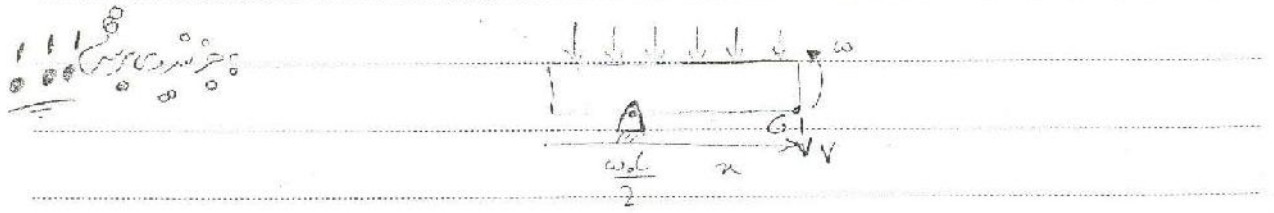
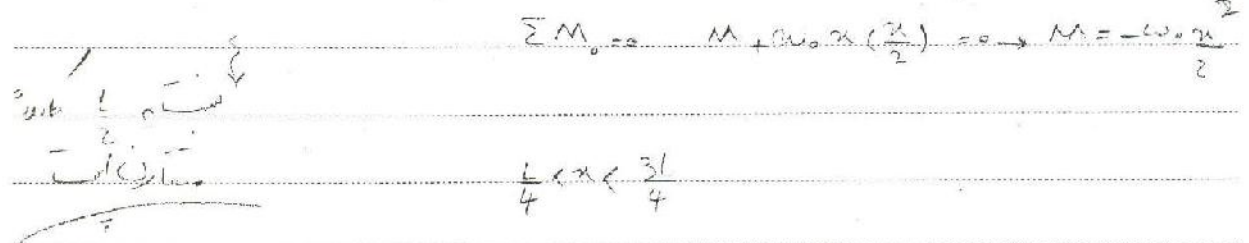
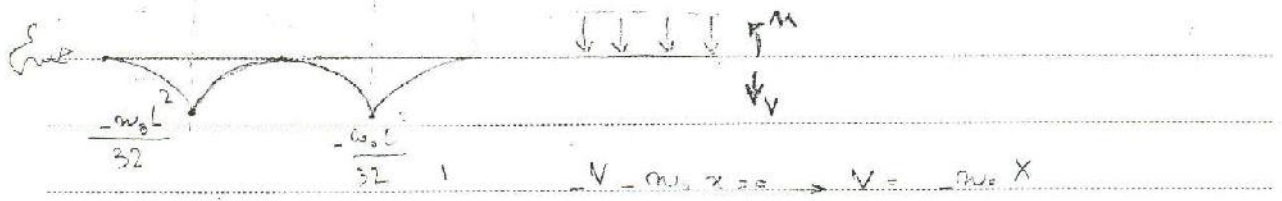
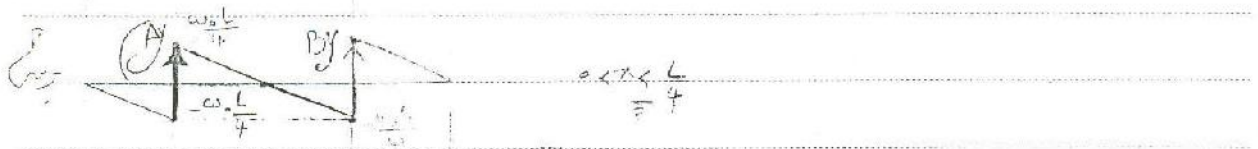
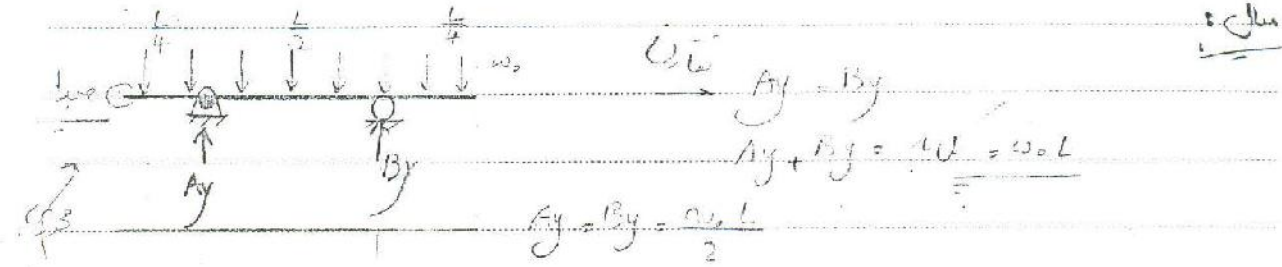
$$M = 20x - 5x^2$$

$$\sum F_y = 0 \quad 10 \times 2 \times 2 \quad V = 20 - 10x$$

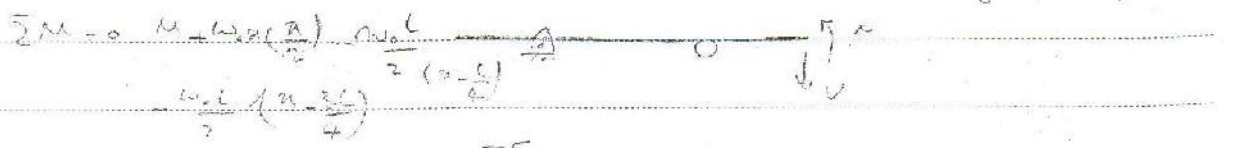
$$+ 20$$

"Potential"

سجل



$M = \frac{\omega_0 L}{2} x - \frac{\omega_0 L^2}{8} - \frac{\omega_0 x^2}{2}$



$\sum F_y = 0 \Rightarrow -V + \omega_0 \left(\frac{L}{2} - x\right) = 0$

Pr

subject:

car. Month. Date.

() ! ω_0 C_1 C_2

کس کا نام؟

$$q = \omega_0$$

! C_1 ! C_2

Points

$$N \quad V = -\omega_0 x + C_1$$

To remember.

$$M = -\frac{\omega_0 x^2}{2} + C_1 x + C_2$$

$$\leftarrow C_1 = V \Big|_{x=0} = 0$$

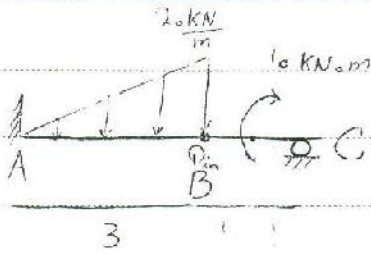
$$\leftarrow C_2 \Big|_{x=0} = 0$$

اجزاء کا ہر دوں ω_0 C_1 C_2 max ω_0 C_1 C_2

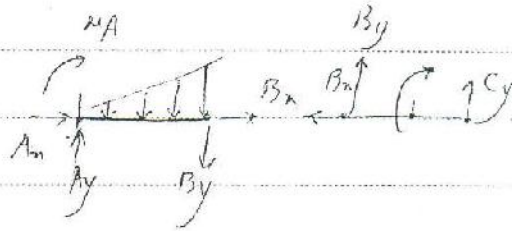
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$\mu = 0$



$$\sum F_x = 0 \rightarrow A_x = B_y = 0$$

$$\sum F_y = 0 \rightarrow A_y - B_y - 2.0 \times \frac{3}{2} = 0$$

$$\sum M_A = 0 \rightarrow -M_A - \frac{2.0 \times 3}{2} \times \frac{2}{3} \times 3 - B_y \times 3 = 0$$

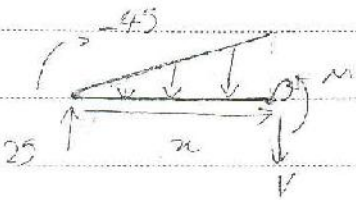
$$A_y = 25 \text{ kN}$$

$$M_A = -60 + 15 = -45$$

$$B_y + C_y = 0 \rightarrow C_y = +5$$

$$\sum M_C = 0 \rightarrow -10 - B_y \times 2 = 0 \rightarrow B_y = -5 \text{ kN}$$

$1 < x < 3$



$$\sum F_y = 0 \rightarrow 25 - V - \frac{2.0}{3} \left(\frac{x}{2} \right) \left(\frac{x}{2} \right) = 0$$

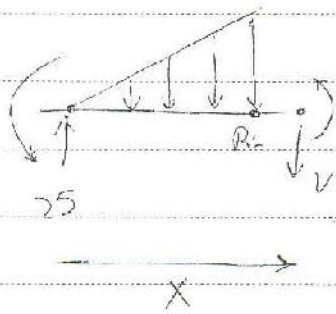
$$N = -\frac{1.0}{3} x^2 + 25$$

$$\sum M_G = 0 \rightarrow -(-45) - 25x + \left(\frac{2.0}{3} \times 2 \right) \left(\frac{x}{2} \right) \left(\frac{x}{3} + x \right) = 0$$

$$\rightarrow M = \frac{1.0}{9} x^3 + 25x - 45$$

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$$3 < X < 4$$

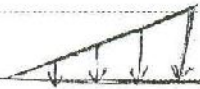
$$\sum F_y = 0 \rightarrow 25 - 3 \cdot \gamma = 0$$

$$\gamma = -5$$

$$\sum M_G = 0 \rightarrow M - 45 \cdot x + 25 \cdot x + 3 \cdot (\gamma \cdot x) \cdot \frac{x}{2} = 0$$

$$M = -5x + 15$$

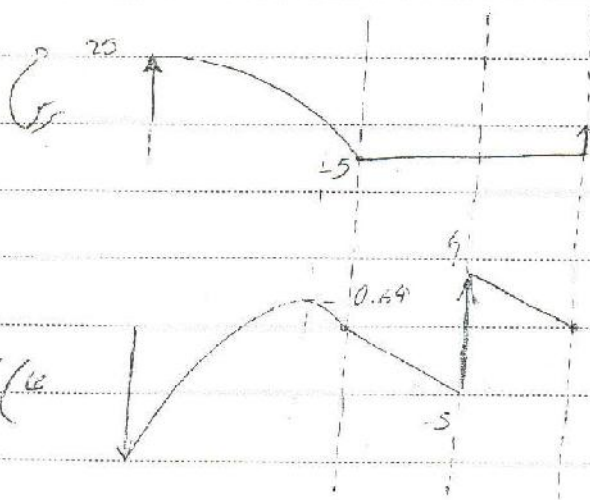
$$4 < X < 5$$



$$M = -5x + 25$$

$$V = -5$$

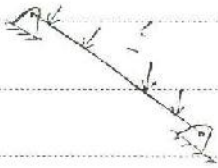
تفریق



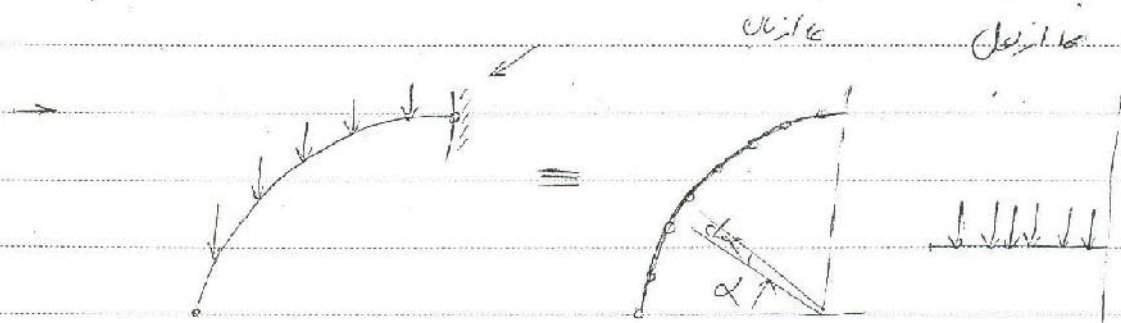
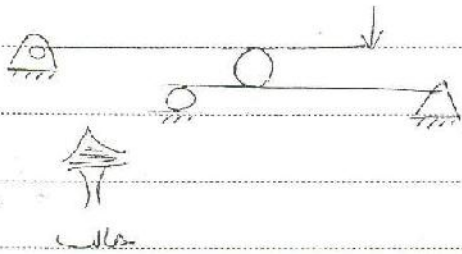
مجدد

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نیز همانطور است که خود بر سر و محل بر سر کنیم



$$V = \int_0^{\pi/2} dF = \int_0^{\pi/2} r d\alpha P_0 = r P_0 \alpha$$

$$A_y = 4 \left| \frac{\pi}{2} \right. = r P_0 \frac{\pi}{2}$$

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$$d\vec{M} = \vec{a} \times d\vec{F} = 2r \sin \frac{\beta}{2} \cdot P_0 r dB \left[\cos \frac{\beta}{2} \hat{U}_r + \sin \frac{\beta}{2} \hat{U}_\theta \right]$$

$$\vec{a} = 2r \sin \frac{\beta}{2} \left(\cos \frac{\beta}{2} \hat{U}_\theta - \sin \frac{\beta}{2} \hat{U}_r \right)$$

$$d\vec{F} = P_0 r dB \hat{k}$$

$$\rightarrow \sum \hat{U}_r \rightarrow M = \int_0^\alpha \frac{\sin \beta}{2} \cos \frac{\beta}{2} dB \left(2r^2 P_0 \right) = r^2 P_0 \left[1 - \cos \alpha \right]$$

$$\sum \hat{U}_\theta \rightarrow M = \int_0^\alpha \sin^2 \frac{\beta}{2} dB \left(2r^2 P_0 \right) =$$

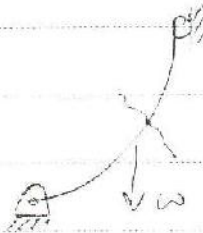
$$r^2 P_0 \left[\alpha - \sin \alpha \right]$$

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$$\tau = \frac{2W}{\pi} (\theta \sin \theta - G \cos \theta)$$
$$\tau = \frac{W}{\pi} \omega (\theta \cos \theta)$$

s



0



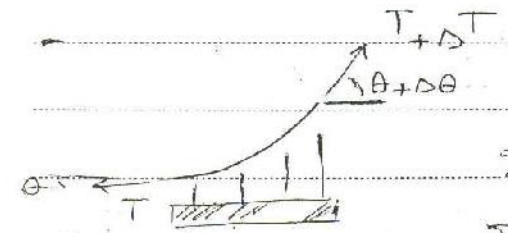
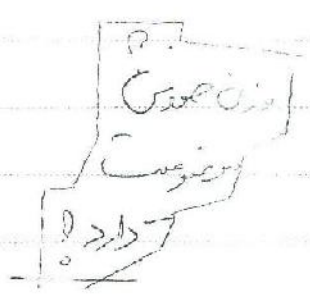
NEW LESSON

Flexible cables

کابل انعطاف پذیر
 کابل کشیده

کابل کشیده
 کابل انعطاف پذیر

کابل کشیده
 کابل انعطاف پذیر



$$\sum F_x = 0 \rightarrow (T + \Delta T) \cos(\theta + \Delta\theta) - T \cos\theta = 0$$

$$\sum F_y = 0 \rightarrow (T + \Delta T) \sin(\theta + \Delta\theta) - T \sin\theta - w \Delta x = 0$$

$$T \sin\theta + \Delta T \sin\theta + \Delta T \cos\theta \Delta\theta - T \sin\theta - w \Delta x = 0$$

$$\Delta T \cos\theta = w \Delta x \rightarrow \Delta T = \frac{w \Delta x}{\cos\theta}$$

$$T \cos\theta = T_0 + \Delta T \sin\theta + \cos\theta \Delta T \rightarrow T_0 = \frac{w y}{\cos\theta}$$

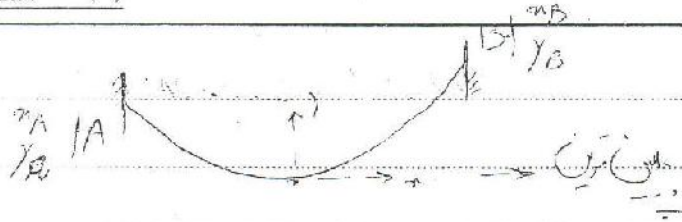
$$d(T \sin\theta) = w dx \rightarrow$$

$$T_0 \frac{d}{dx} (\tan\theta) = w \frac{dy}{dx} \rightarrow \frac{dy}{dx^2} = \frac{w \cos\theta}{T_0}$$

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حل المسائل رقم 1



$$w(x) = \frac{w}{L} x$$

$$\frac{d^2 y}{dx^2} = \frac{w}{T_0} \rightarrow \frac{dy}{dx} = \frac{w}{T_0} x + C_1$$

$$x=0 \rightarrow \frac{dy}{dx} = 0 \rightarrow C_1 = 0$$

$$x=L \rightarrow y = y_B$$

$$y = \frac{1}{2} \frac{w}{T_0} x^2 + C_2 \rightarrow \boxed{y = \left(\frac{1}{2} \frac{w}{T_0}\right) x^2} \rightarrow \text{مسألة}$$

T_{max} (توجد في منتصف المسافة بين A و B)

(T = T₀ في منتصف المسافة)

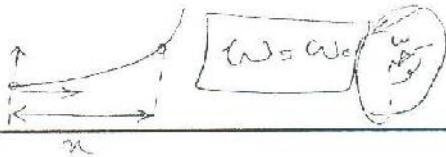
$$y_B = \frac{1}{2} \frac{w_0}{T_0} x_B^2 \rightarrow T_0 = \frac{w_0}{2} \frac{x_B^2}{y_B}$$

$$y = \left(\frac{x}{x_B}\right)^2 y_B$$

من أجل أن يكون A Max

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$$T(n) = \sqrt{T_0^2 + (\omega_0 n)^2}$$

$$T(n) = \sqrt{\frac{\omega_0^2 n_B^4}{4} + \omega_0^2 n} = \omega_0 \sqrt{n + \frac{n_B^4}{4}}$$

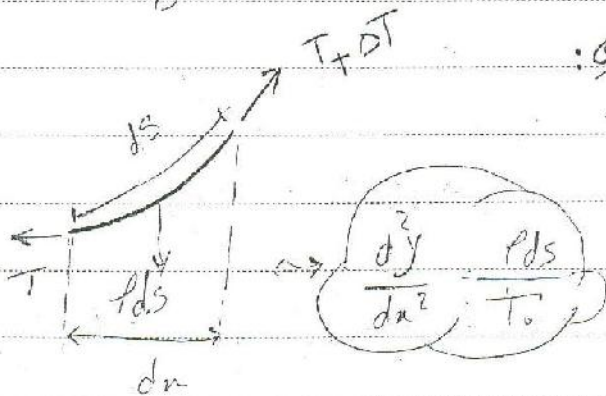
$$T_{\text{max}} \Big|_{n_B} \rightarrow \omega_0 \sqrt{n_B + \frac{n_B^4}{4}}$$

Work done: $S = \int_0^{n_B} T(n) dn = \int_0^{n_B} \sqrt{1 + \left(\frac{\omega_0}{T_0} n\right)^2} dn$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!} x^2 + \dots$$

$$\int_0^{n_B} \left(1 + \left(\frac{\omega_0}{T_0} n\right)^2\right)^{\frac{1}{2}} dn = \int_0^{n_B} \left(1 + \frac{1}{2} \left(\frac{\omega_0}{T_0} n\right)^2 - \dots\right) dn = n_B \left[1 + \frac{2}{3} \left(\frac{\omega_0}{T_0}\right)^2 \frac{n_B^2}{3} - \dots\right]$$

$$\left| \frac{\omega_0}{T_0} \right| < \frac{1}{2}$$



! ω_0

$$p ds = \omega_0 dx$$

$$\omega_0 = \frac{p ds}{dx}$$

→ $\int \dots$

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$$\frac{dy}{dx} = \frac{P}{T_0} \sqrt{1 + \left(\frac{dy}{dx}\right)^2}$$

$$\boxed{\frac{dy}{dx} = \frac{P}{T_0} \sqrt{1 + \left(\frac{dy}{dx}\right)^2}}$$

$$P' = \frac{P}{T_0} \sqrt{1 + P^2} \Rightarrow \frac{dP}{dx} = \frac{P}{T_0} \sqrt{1 + P^2}$$

$$\frac{dP}{\sqrt{1 + P^2}} = \frac{P}{T_0} dx \Rightarrow \int \frac{dP}{\sqrt{1 + P^2}} = \ln \left(\frac{P + \sqrt{1 + P^2}}{T_0} \right) = \frac{P}{T_0} x + C$$

$$P = \frac{dy}{dx} \rightarrow e^{\frac{P}{T_0} x + C} = P + \sqrt{1 + P^2}$$

$$\rightarrow x=0 \rightarrow e^C = 0 + \sqrt{1 + P^2} \rightarrow C = \ln(1)$$

$$\boxed{e^{\frac{P}{T_0} x} = P + \sqrt{1 + P^2}}$$

$$P + e^{\frac{P}{T_0} x} = 2Pe^{\frac{P}{T_0} x} = 1 + P$$

$$\rightarrow 2Pe^{\frac{P}{T_0} x} - e^{\frac{P}{T_0} x} + 1 = 0 \quad \frac{P}{T_0} x = -\frac{P}{T_0} x$$

$$\rightarrow \frac{e^{\frac{P}{T_0} x} - 1}{2e^{\frac{P}{T_0} x}} = \frac{1}{2} e^{-\frac{P}{T_0} x} = P$$

$$\sinh\left(\frac{P}{T_0} x\right) = \frac{dy}{dx}$$

$$\sinh\left(\frac{P}{T_0} x\right) dx = \frac{dy}{dx} \Rightarrow y = \frac{T_0}{P} \cosh\left(\frac{P}{T_0} x\right) + C$$

$$0 = \frac{T_0}{P} + C \Rightarrow C = -\frac{T_0}{P}$$

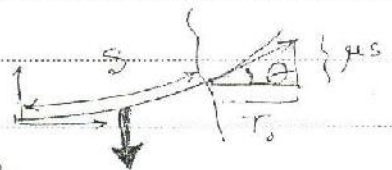
$$f = \frac{1}{m} \left(\frac{d^2 y}{dx^2} + \frac{1}{l} y \right)$$

طول سیم $(\frac{M}{m})$

$$y = \frac{T_0}{P} \cosh \frac{P}{T_0} x - \frac{T_0}{P}$$

معمولاً
 ...
 ! ! ! !

پس در این صورت چه می شود؟



$P = w$

$$\tan \theta = \frac{dy}{dx} \rightarrow \frac{P x}{T_0} \rightarrow \frac{P x}{T_0} = \left(\sinh \frac{P}{T_0} x \right) \left(\frac{T_0}{P} \right)$$

$$T^2 = (P x)^2 + T_0^2 = T_0^2 \left(1 + \left(\frac{P x}{T_0} \right)^2 \right) = T_0^2 \left(1 + \sinh^2 \frac{P}{T_0} x \right)$$

$$= T_0^2 \cosh^2 \frac{P}{T_0} x \Rightarrow T = T_0 \cosh \frac{P}{T_0} x$$

Once again $T = T_0 \cosh \frac{P}{T_0} x$

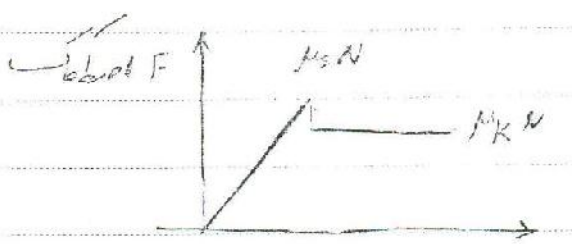
$$T_{max} = T_0 \cosh \frac{P}{T_0} x_{max}$$

پس در این صورت چه می شود؟

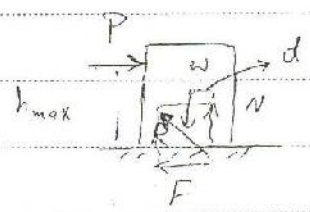
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استطاب



جزء N : جزء P
 در تمام طول سطح بین سطح و سطح



جزء N : جزء P

$$\sum F_x = 0 \quad -Ph + wd = 0$$

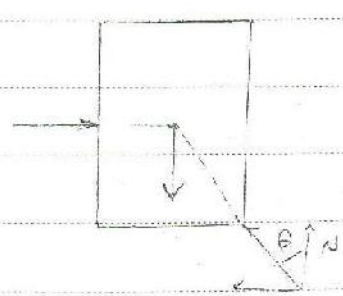
$$Ph = wd$$

$$h = \frac{wd}{P} \rightarrow \frac{h}{\text{max}} = \frac{w}{P} d_{\text{max}}$$

$$\sum F_y = 0 \rightarrow N = w$$

$$\sum F_x = 0 \rightarrow f = P = \mu N$$

$$\sum M = 0 \quad Ph = wd$$



$$\tan \theta = \frac{\mu N}{N} = \mu$$

$$h_{\text{max}} = \frac{b}{2} = \frac{b}{2\mu}$$

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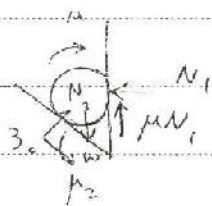


Fig. V-4

$$\sum F_x = 0 \quad -N_1 + N_2 \cos 60 + \mu N_2 \cos 30 = 0$$

$$\sum F_y = 0 \quad \mu N_1 + \mu N_2 \sin 30 + N_2 \cos 30 = W$$

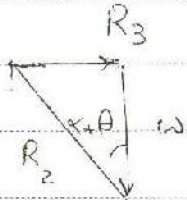
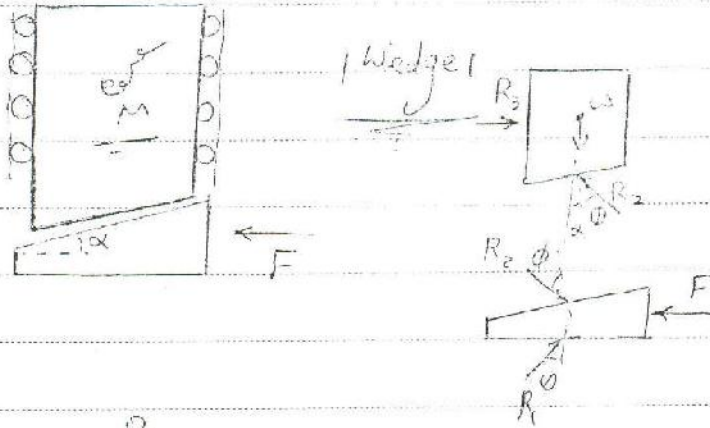
$$\sum M = 0 \rightarrow \mu(N_1 + N_2) \cdot M$$

اگر μ را حذف کنیم

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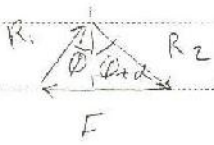
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$\tan \phi = \mu$



$R_2 \cos(\alpha + \phi) = W$

$R_2 \sin(\alpha + \phi) = R_3$



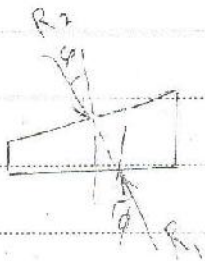
$R_1 \cos \phi = R_2 \cos(\alpha + \phi)$

$R_1 \sin \phi + R_2 \sin(\phi + \alpha) = F$

$F = W \tan \phi + W \tan(\phi + \alpha)$

$F = W (\tan \phi + \tan(\phi + \alpha))$

Self lock condition $\mu > \tan(\phi + \alpha)$

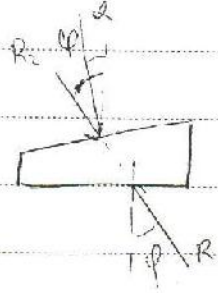
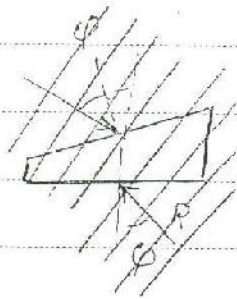


Self lock condition $\mu > \tan(\phi + \alpha)$

$R_1 = R_2$

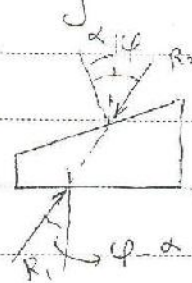
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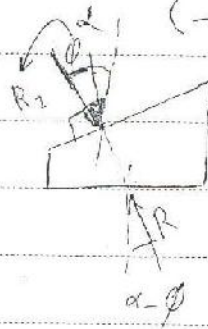
✓

Slipping impending at lower surface.



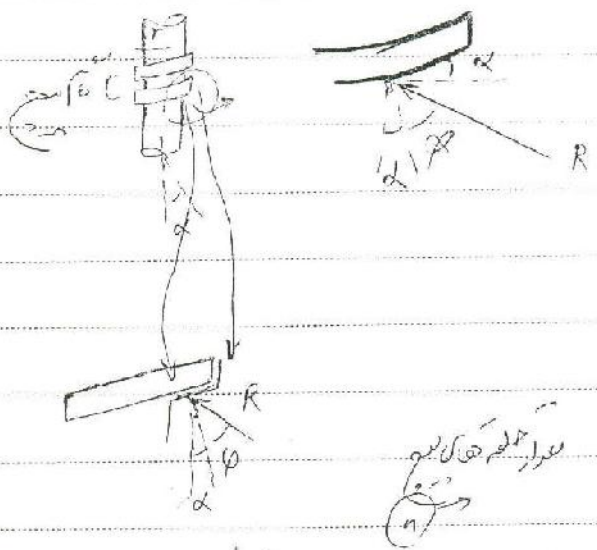
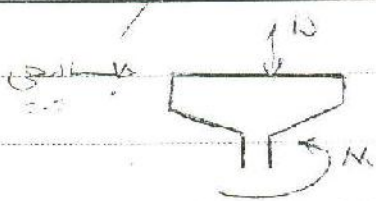
Slipping at upper surface.

$\phi > \alpha$ → self lock
 $\phi < \alpha$ *



Subject:

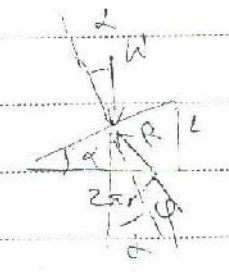
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$\tan \phi = \mu$ $\sum R \sin(\phi + \alpha)$

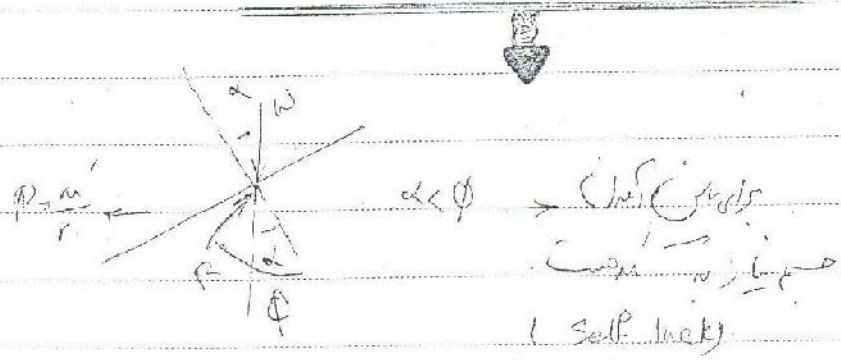
$\sum F_y = 0 \rightarrow W = \sum R \cos(\phi + \alpha)$

$\sum M = 0 \rightarrow M = \sum R \sin(\phi + \alpha)$



to raise

$M = W r \tan(\phi + \alpha)$

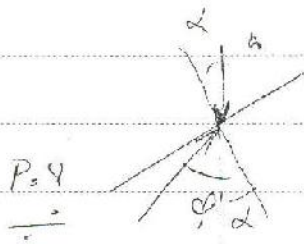


$\alpha < \phi$ → (Self lock)
 (Self lock)

$M = W r \tan(\phi - \alpha)$

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$\alpha > \phi$

$$M = W r \tan(\alpha - \phi)$$



Egol. P. Polov!

mechanics of materials

beer Johnson!

shames!

→ Schaum outline series

} engineering mechanics of material
 S.B.P. mudi
 J.V. mandab
 'D

→ mark $\frac{P}{Q}$ 30%

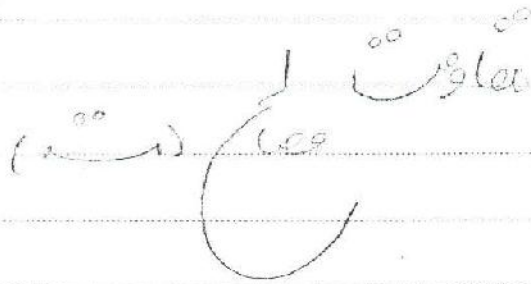
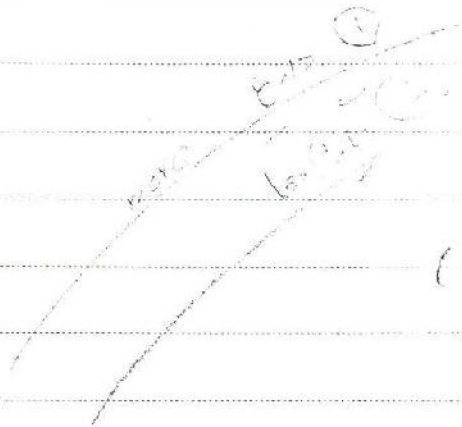
$\frac{P}{Q}$ 50%

CANDOO

$\frac{P}{Q}$ 29%

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Stress ← σ (تکون) و τ (قوت) (shear) و ϵ (displacement) (تکون) و γ (strain) (تکون)

safety factor (تکون)

(displacement) (تکون) و (strain) (تکون)

stress concentration (تکون)

بابت تکون و σ (تکون)

بابت تکون و τ (تکون)

تکون

تکون

تکون

تکون

تکون و σ (تکون)

تکون و τ (تکون)

تکون و σ (تکون)

تکون و τ (تکون)

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تاریخ: ۱۵/۱۰/۱۳۹۸

توجه: نیروهای سطحی (عمود) را علامت مثبت و نیروهای سطحی (مماس) را علامت منفی در نظر بگیرید.

نیروهای کشش را در جهت مثبت و نیروهای اصطکاک را در جهت منفی در نظر بگیرید.

نیروهای عمود بر سطح را علامت مثبت و نیروهای مماس بر سطح را علامت منفی در نظر بگیرید.

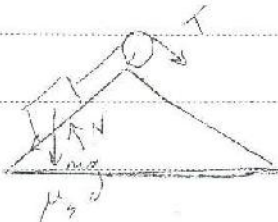
$$\sum W_x = \sum W_y = \sum W_z = 0$$

به صورت کلی برای هر نیروی موازی داریم:

موازنه در جهت عمود بر سطح:

$$\sum F_{\perp} = 0 \Rightarrow N - mg \cos \theta = 0$$

از رسم اصطکاک در جهت مثبت استفاده می‌کنیم.



$$T \sin \theta = mg \sin \theta + N \cos \theta + \mu N \cos \theta$$

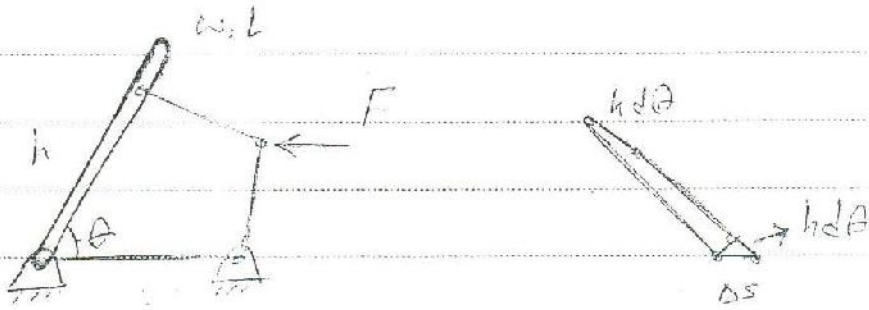
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Month. _____

Date. _____

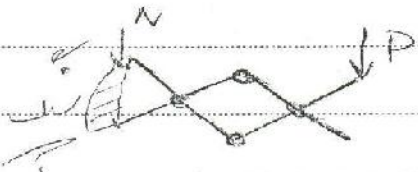
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$$-N \sin \theta + F D_S = 0$$

$$-\frac{wt}{2} \cos \theta + F h d \theta = 0 \rightarrow F = \frac{wt}{4h} \sin 2\theta$$

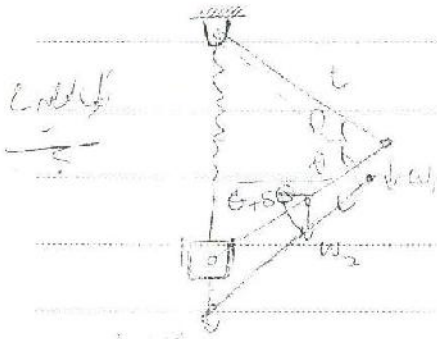
$$D_S = \frac{h d \theta}{\sin \theta}$$



$$N = 1.6 P$$

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Hand 7

$$l = 2l \sin \theta$$
$$W_2 = 2l \cos \theta \Delta \theta$$

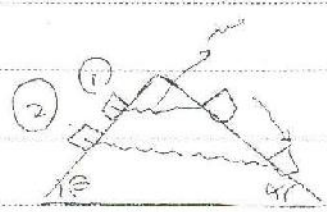
Left

$$\frac{W_2 \sin \theta}{2}$$

Right

$$W_2 \frac{3 \sin \theta}{4}$$

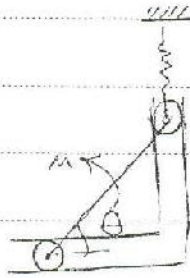
is, b $K \Delta L \Delta \theta$



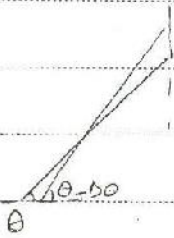
$P = \frac{W_2 \sin \theta}{2}$

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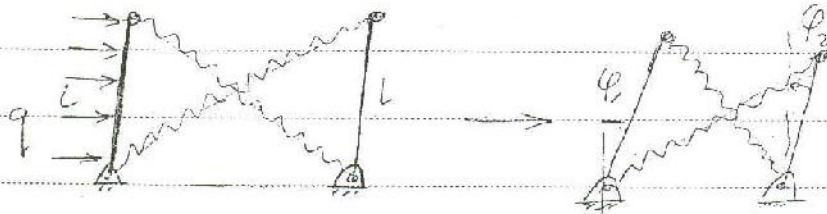
توازن $\sum F_x = 0 \rightarrow \dots$



$$w \, dy - F_k \, \delta y - \frac{w \, \delta y}{2} = 0$$

$$y = l \sin \theta \rightarrow \delta y = l \cos \theta \, \delta \theta$$

$$F_k = k L \sin \theta$$



$$w = \int_0^l q = \phi_1 \, dz = \frac{q \phi_1}{2} z^2 \Big|_0^l = \frac{q \phi_1}{2} l^2$$

$$U_e = kL^2 \frac{(\phi_1 - \phi_2)^2}{2} + kL^2 \frac{\phi_1^2}{4} + kL^2 \frac{\phi_2^2}{4}$$

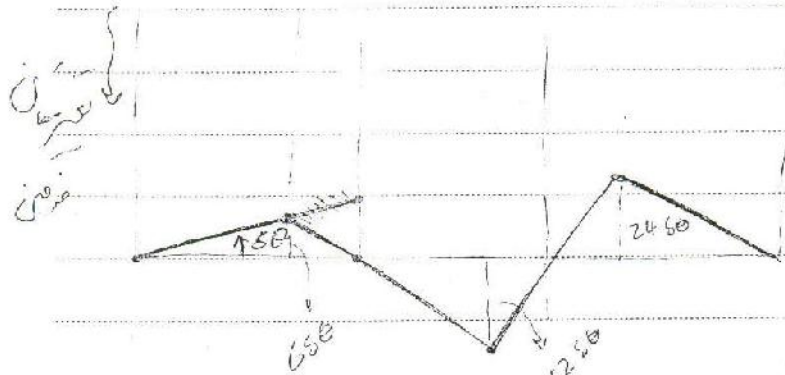
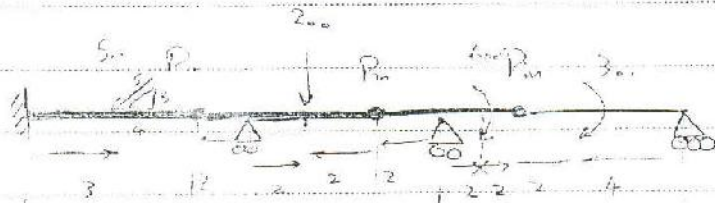
$$\frac{qL^2}{2} = kL^2 \left[(\phi_1 - \phi_2) + \frac{\phi_1}{2} \right]$$

$$\frac{\partial w}{\partial \phi_1} = \frac{\partial U}{\partial \phi_1}$$

$$0 = kL^2 \left[-(\phi_2 - \phi_1) + \phi_1 \right]$$

$$\frac{\partial w}{\partial \phi_2} = \frac{\partial U}{\partial \phi_2}$$

It's been giving these days!



$$S_w = M A 80 - 3 \times (350) - 2 \times 600 + 6 \times 600 + 3 \times (450) = 0$$

$$\rightarrow M = 2100$$

KANDOO

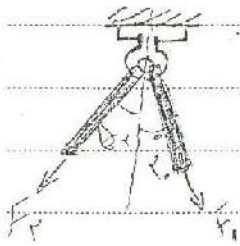
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ان کے لیے دو قوتیں F_1 اور F_2 کے ساتھ 1 kN کی قوت کے ساتھ ساتھ:

الف) ان کے لیے F_1 اور F_2 کے درمیان $\theta = 30^\circ$

ب) ان کے لیے F_1 اور F_2 کے درمیان $\theta = 30^\circ$ کے ساتھ ساتھ F_1 اور F_2 کے درمیان $\theta = 30^\circ$

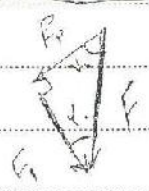


الف) $F_1 \sin \theta = F_2 \sin \theta$
 $F_1 \cos \theta + F_2 \cos \theta = 1\text{ kN}$ } $\rightarrow F_1, F_2$

ب) $\frac{F_1}{\sin \theta} = \frac{F_2}{\sin \theta} = \frac{F}{\sin \theta}$

ب) $F_1 = \frac{F_1 \sin \theta}{\sin \theta} \Rightarrow \sin \theta = \frac{F_1 \sin \theta}{F_2} \sqrt{1 - \frac{F_1^2 \sin^2 \theta}{F_2^2}}$

$F_1 \cos \theta + F_2 \sqrt{1 - \frac{F_1^2 \sin^2 \theta}{F_2^2}} = 1\text{ kN}$



$F_1 = F \cos \theta = 94.7\text{ N}$

$F_2 = F \sin \theta = 312\text{ N}$

کسی تقریباً 312 N اور 94.7 N کے ساتھ ساتھ