

17-05-2020

ME6230: END-SEMESTER

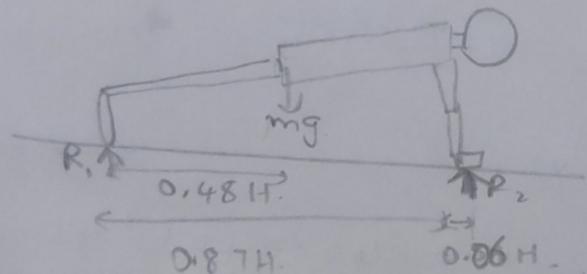
S.TARUN PRASA

TAKE-HOME EXAM.

ME17B114

- My Height: 170 cm.
- My Weight: 86 kg.

(1). (i) Plank:

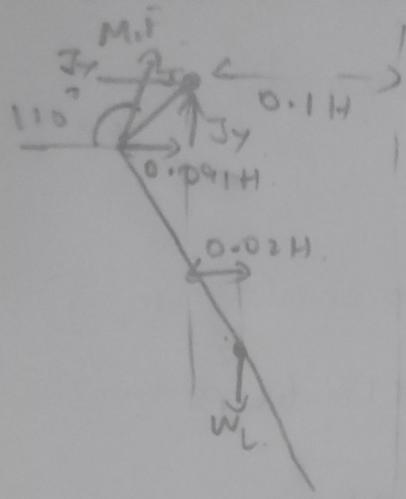


Balancing moment about foot.

$$R_2 = \frac{mg \times 0.48}{0.87 + 0.06} = 434.99 \text{ N}.$$

$$\Rightarrow R_1 = mg - 434.99 \text{ N} = 407.81 \text{ N}$$

Hip Analysis (Plank):



$$\sum M_J = 0 -$$

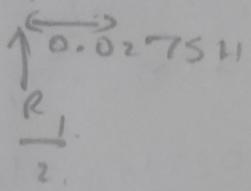
$$\Rightarrow M.F \sin 70^\circ \times 0.091 H$$

$$= W_2 \times 0.02 H + R_1 \times \frac{(0.191 - 0.0275) H}{2}$$

$$\Rightarrow M.F \times 0.07 = 334.76 \times 0.02$$

$$+ \frac{407.81}{2} \times 0.1635$$

$$\Rightarrow M.F = 571.91 \Rightarrow M.R = \frac{1048.17 N}{2}, \text{ Stabilised,}$$

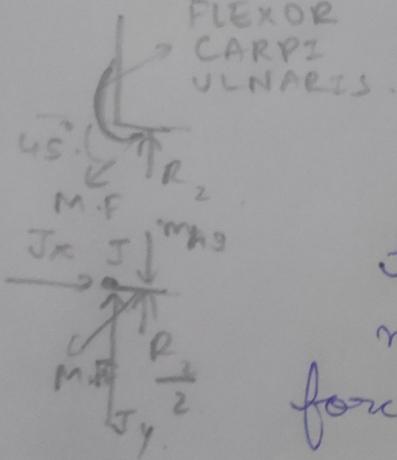


$$\sum F_x = 0 \Rightarrow J_x = -M.F \cos 70^\circ = -\frac{-362.20 N}{571.91}$$

$$\Rightarrow J_y = 334.76 - \frac{407.81}{2} - \frac{1048.17 \sin 70^\circ}{2}$$

$$\Rightarrow J_y = -88.4 \text{ N} \Rightarrow J_y = -311.74$$

Wrist Analysis:



Assuming flexor carpi ulnaris to be the sole stabilising muscle acting at the middle of the palm and the reaction force also acting at the middle of the palm. Assuming muscle force at 45° to palm.

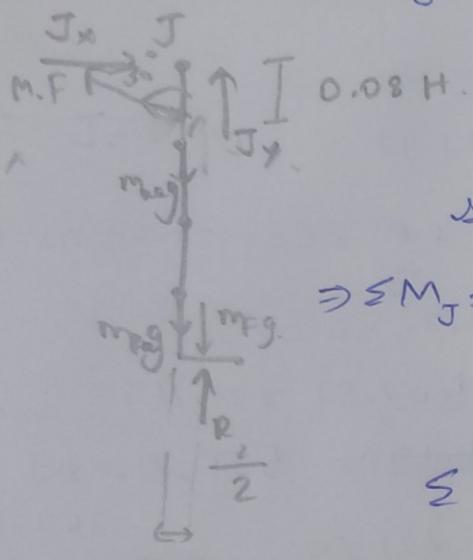
$$\sum M_J = 0 \Rightarrow M.F \sin 45^\circ = \frac{R_2}{2} - m_h g = \frac{R_2}{2} - 0.006 mg$$

$$\Rightarrow M.F = \sqrt{2} \left(\frac{434.99}{2} - 0.006 \times 9.8 \times 8.6 \right) = \frac{608.202 N}{2}$$

$$\sum F_y = 0 \Rightarrow J_y = \frac{R_2}{2} = 300.39 N$$

$$\sum F_x = 0 \Rightarrow J_x = M.F \cos 45^\circ = 429.93 N, 212.44 N$$

Shoulder analysis



Assuming latissimus dorsi to stabilize the shoulder with parameters as shown in the diagram.

$$\Rightarrow \sum M_J = 0 \Rightarrow MF \sin 30^\circ \times 0.08H = 0.08H \left(\frac{R_2}{2} - m_h g \right)$$

$$\Rightarrow MF = \cancel{644.89N} \quad 318.66 N$$

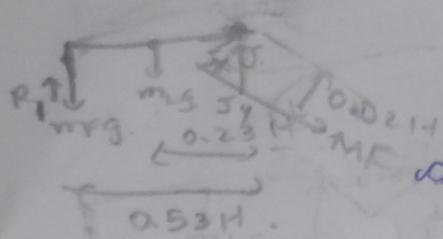
$$\sum F_y = 0 \Rightarrow J_y = -(MF \cos 30^\circ + \frac{R_2}{2}) + (m_u + \frac{m_f}{2} + m_h) g$$

$$\Rightarrow J_y = \frac{-266.65}{\cancel{-912.01}} + (0.0271 + 0.0162 + 0.006) \times 86$$

$$\Rightarrow J_y = \frac{-266.65}{\cancel{-912.01}} + 41.38 = \cancel{-810.63} \quad \cancel{-225.27} \quad \cancel{\times 9.8}$$

$$J_x = MF \sin 30^\circ = \cancel{322.45N} \quad 159.33 N$$

L-5 Sacral Analysis:



In the plank position the ~~abdominal muscles are the~~
~~major stabiliser~~
~~assuming the erector spinae to act.~~

$$M.F \times 0.02H = +R_x \times 0.53H.$$

In the plank position

assuming the abdominal $\Rightarrow (m_f + \cancel{m_L} \times 0.53H + m_L \times 0.23H) \times g$.
 muscles to be the major stabilisers

$$\Rightarrow M.F \times 0.02H = +407.81 \times 0.53H$$

$$\Rightarrow \left[\left(\frac{1.37 \times 2}{100} \times 0.53 \right) + \left(\frac{(14.16 + 4.33) \times 2}{100} \times 0.23 \right) \right] \times 86 \times 9.8 \times H.$$

$$\Rightarrow M.F \times 0.02 = -0.1 \times 86 \times 9.8 + 216.14$$

$$\Rightarrow M.F = 6593N$$

$$\sum F_x = 0 \Rightarrow J_x + M.F (\cos 45^\circ) = 0$$

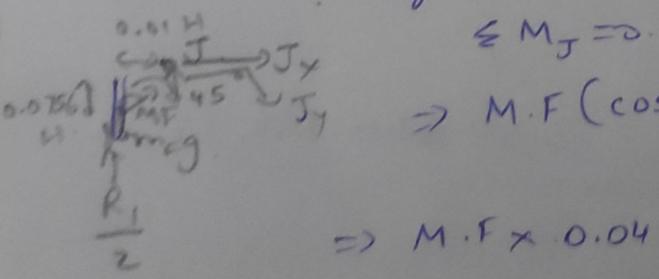
$$\Rightarrow J_x = -\frac{6593}{\sqrt{2}} = -4661.96N$$

$$\sum F_y = 0 \Rightarrow J_y + M.F \sin 45^\circ + R_x = (m_L + m_f)g$$

$$\Rightarrow J_y + 4661.96 + 407.81 = \underbrace{(14.16 + 4.33 + 1.37) \times 2 \times 86 \times 9.8}_{100}$$

$$\Rightarrow J_y = 334.76 - 401.81 - 4661.96 = -4735.01N$$

Ankle Analysis:



$$\sum M_J = 0$$

$$\Rightarrow M.F (\cos 45^\circ \times 0.0756H - \sin 45^\circ \times 0.01H)$$

$$= (R_1 - m_f g) \times 0.01H$$

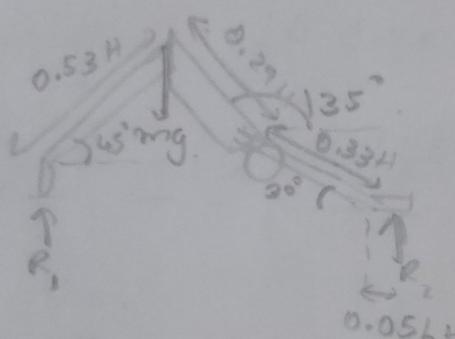
$$\Rightarrow M.F \times 0.046 = \left(\frac{407.81}{2} - \frac{1.37 \times 86 \times 9.8}{100} \right) \times 0.01$$

$$\Rightarrow M.F = 8614.43N \cdot 86.14N / 41.82N$$

$$\sum F_x = 0 \Rightarrow J_x = -M \cdot F \cos 45^\circ = -60.91 \text{ N} = -29.57 \text{ N}$$

$$\begin{aligned}\sum F_y = 0 \Rightarrow J_y &= m_F g - \frac{R_1}{2} - M F \sin 45^\circ \\ &= \frac{1.37}{100} \times 86 \times 9.8 - \frac{407.81}{2} - \frac{86.14}{52} = 29.57 \\ &= -\cancel{482.407 \text{ N}} - 221.93 \text{ N.}\end{aligned}$$

(ii) Dog-facing ground posture:



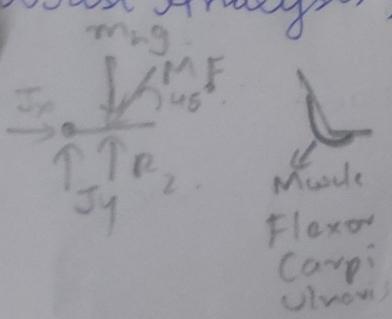
Assuming the posture to have the following values with references from slides anthropometric data & online photos

Balancing moment about foot:

$$\begin{aligned}\Rightarrow mg \times 0.53H \times \cos 45^\circ &= R_2 \times [0.53H \cos 45^\circ + 0.29H \cos 45^\circ \\ &\quad + 0.33H \cos 30^\circ + 0.056H] \\ \Rightarrow R_2 &= \frac{86 \times 9.8 \times 0.53}{0.922 \times \sqrt{2}} \\ &= 342.72 \text{ N.}\end{aligned}$$

$$\Rightarrow R_1 = mg - R_2 = 500.08 \text{ N.}$$

Wrist Analysis: All assumptions valid as per the wrist analysis in the plank part.



$$\sum M_J = 0 \Rightarrow MF \sin 45^\circ = \frac{R_2}{2} - m_h g.$$

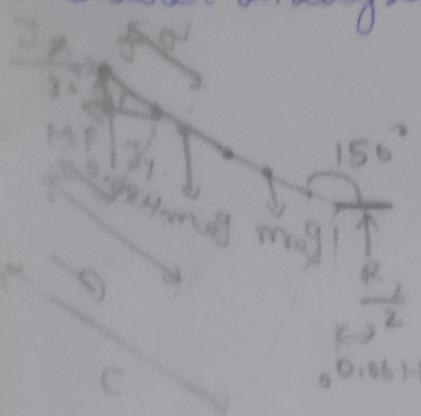
$$\Rightarrow MF = \sqrt{2} (342.72/2 - 0.006 \times 9.8 \times 86).$$

$$\Rightarrow MF = \cancel{412.53} \text{ N} = 235.19 \text{ N.}$$

$$\sum F_y = 0 \Rightarrow J_y = 0.$$

$$\sum F_x = 0 \Rightarrow J_x = MF \cos 45^\circ = \cancel{337.66} \text{ N} = 166.30 \text{ N.}$$

Shoulder Analysis: Carrying forward the same assumptions from shoulder analysis in plank posture.



$$a = \frac{57.72 \times 0.18611}{100} = 0.1074$$

$$b = 0.18611 + \frac{45.74 \times 0.146 H}{100} = 0.253 H$$

$$c = 0.18611 + 0.146 H = 0.332 H$$

$$\sum M_J = 0 \Rightarrow m_{ua} g \times a \cos 30^\circ + m_{fa} g \times b \cos 30^\circ + MF \sin 30^\circ \times 0.0874 \\ = \frac{R_2}{2} (c \cos 30^\circ + 0.0614)$$

$$\Rightarrow \left(0.0271 \times 0.107 \times \frac{\sqrt{3}}{2} + 0.0162 \times 0.253 \times \frac{\sqrt{3}}{2} \right) \times 86 \times 9.8 + MF \times 0.04$$

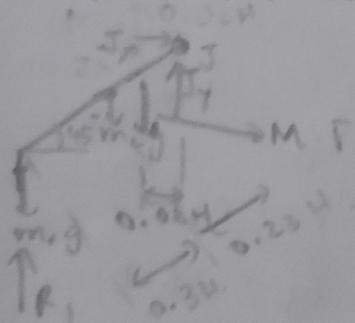
$$= \frac{342.72}{2} \left(0.332 \times \frac{\sqrt{3}}{2} + 0.06 \right)$$

$$\Rightarrow MF = \frac{-5.11 + \cancel{+ 59.55}}{0.04} = \cancel{2849.88} + \cancel{1361.03} N$$

$$\sum F_x = 0 \Rightarrow J_x = MF = \cancel{2849.88} + \cancel{1361.03} N$$

$$\sum F_y = 0 \Rightarrow J_y = (m_{ua} + m_{fo}) g - \frac{R_2}{2} \\ = (0.0271 + \cancel{0.0162}) \times 9.8 \times 86 - \frac{342.72}{2} \\ \Rightarrow J_y = -356.28 N - 134.87 N$$

L-5 Sacral Analysis:



Going with the same assumptions for the sacral analysis in the plank part.

$$\sum M_J \Rightarrow MF \times 0.02H + m_L g \times 0.23 \times \cos 45^\circ \\ + m_F g \times 0.53 \times \cos 45^\circ \\ = R_1 \times 0.53 \times \cos 45^\circ$$

$$\Rightarrow MF = \frac{560.08 \times 0.53 - \left(\frac{1.37 \times 2}{100} \times 0.53 + \frac{(14.16 + 4.33) \times 2 \times 0.23}{100} \right)}{0.53 \times 0.02} \times 86 \times 9.8 \\ = \cancel{128.02} + 6403.55 N$$

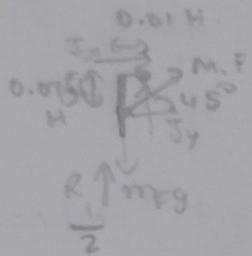
$$\sum F_x = 0 \Rightarrow J_x = 0.$$

$$\sum F_y = 0 \Rightarrow J_y = M \cdot F + (m_L + m_F)g - R,$$

$$\Rightarrow J_y = 6403.55 + \left(\frac{14.16 + 4.33 + 1.37}{100} \times 2 \times 86 \times 9.8 - 500.08 \right)$$

$$= 6238.23 N.$$

Ankle Analysis:



$$\sum M_J = 0.$$

$$M \cdot F (\cos 45^\circ \times 0.0756 - \sin 45^\circ \times 0.01H)$$

$$= (R_1 - m_F g) \times 0.01H$$

$$\Rightarrow M \cdot F \times 0.046 = \left(\frac{500.08}{2} - \frac{1.37}{100} \times 86 \times 9.8 \right) \times 0.01$$

$$\Rightarrow M \cdot F = 106.208 N, 51.85 N.$$

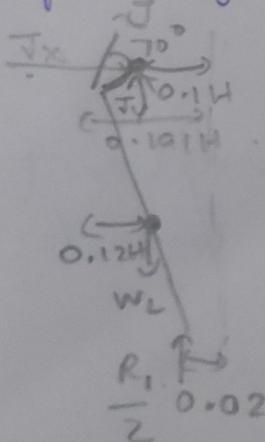
$$J_x = -M \cdot F \cos 45^\circ = -75.09 N, -36.66 N.$$

$$J_y = m_F g - \frac{R_1}{2} - M \cdot F \sin 45^\circ.$$

$$= \frac{1.37}{100} \times 86 \times 9.8 - \frac{500.08}{2} - \frac{106.2}{\sqrt{2}}$$

$$\Rightarrow J_y = -583.63 N, -275.16 N.$$

Hip Analysis:



$$\sum M_J = 0$$

$$\Rightarrow M \cdot F \sin 70^\circ \times 0.091H = R_1 \times 0.02H$$

$$+ R_1 \times (0.191 - 0.0275H)$$

$$\Rightarrow M \cdot F \times 0.07 = 334.76 \times 0.02$$

$$+ \frac{500.08}{2} (0.16)$$

$$\Rightarrow M \cdot F = 1253.64 N, 667.16 N.$$

$$\sum F_x = 0 \Rightarrow J_x = -M \cdot F \cos 70^\circ = -800.32 N, -422.53 N$$

$$\sum F_y = 0 \Rightarrow J_y = W_L - R_1/2 - M \cdot F \sin 70^\circ$$

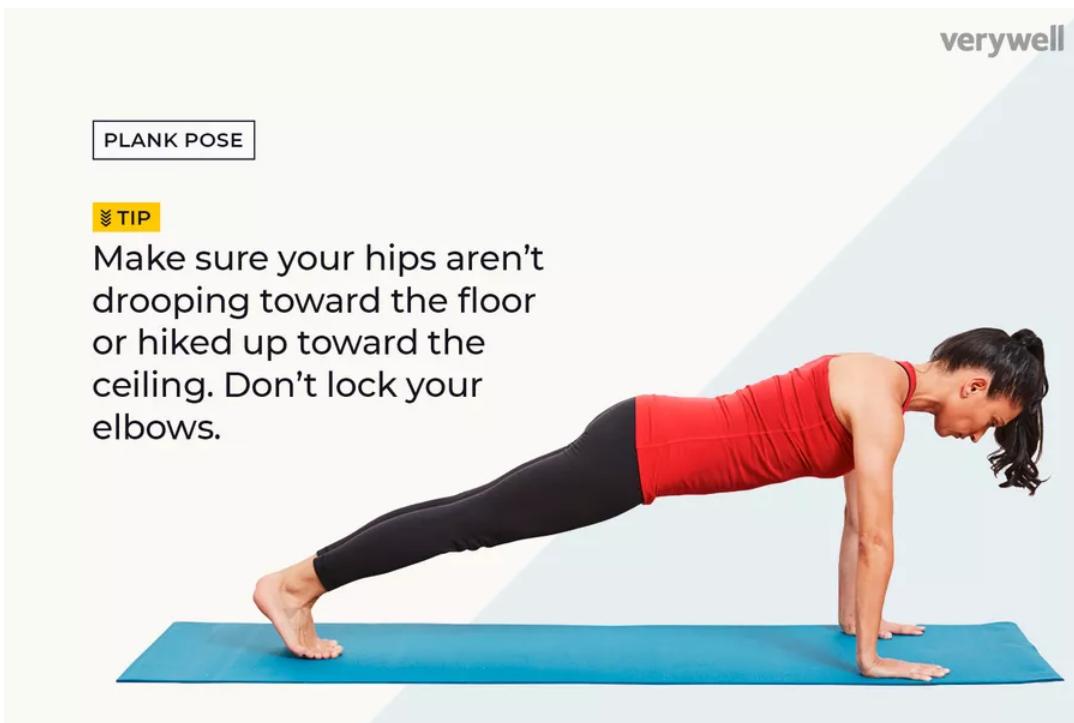
$$= 334.76 - \frac{500.08}{2} - \frac{800.32}{2} \times \frac{\sin 70^\circ}{667.16 N}$$

$$\Rightarrow J_y = -443.28 N, -431.59 N.$$

Question 1 Picture Source

Source Link:

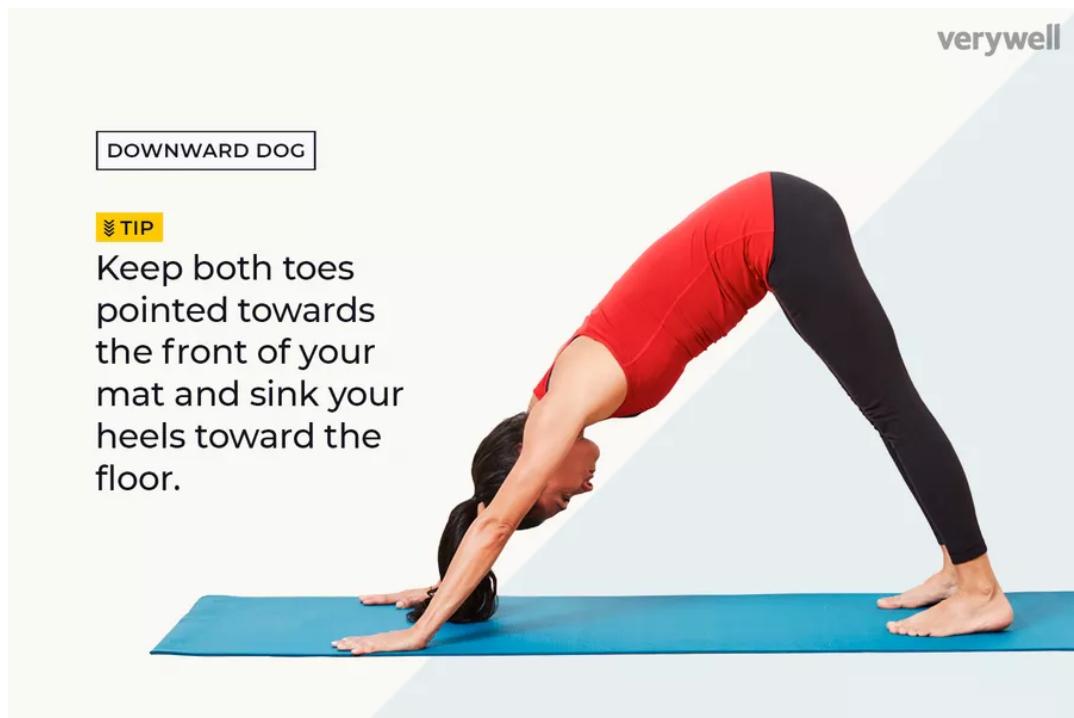
<https://www.verywellfit.com/illustrated-stepbystep-sun-salutation-3567187>



PLANK POSE

Tip

Make sure your hips aren't drooping toward the floor or hiked up toward the ceiling. Don't lock your elbows.



DOWNTWARD DOG

Tip

Keep both toes pointed towards the front of your mat and sink your heels toward the floor.

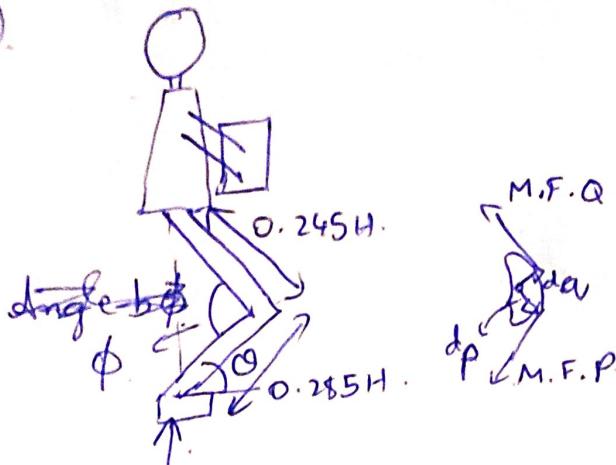
Question 2 Solution

Product Name	Picture	Key Features	Disadvantages	Suggestions
Ossur Balance™ Knee		Possesses a four-bar geometric design which can be easily adjusted to optimize the required balance between stability and walking dynamics for each individual. Balance Knee facilitates easy kneeling. The design is easily adjustable without requiring disassembly. Mid-swing shortening allows the prosthesis to swing more easily through each step.	Can only support a single slow speed although it is marketed as the USP of the product. Although modelled for in-home use doesn't possess flexion resistance to assist easy sitting.	The weight of the knee is at 600 grams and this can be improved for a prosthetic knee without pneumatic or computerised assistance.
Ossur Balance™ Knee OFM1		It is a mechanical polycentric knee joint that is suitable for users with high safety requirements. The knee can be locked (e.g. when standing) to cater to new amputees and less mobile users. Ideal for first standing and walking exercises. Flexion and extension can be released depending on the patient's progress. More ground clearance for a safer and more confident gait. Rates of flexion and extension can be adapted to the user.	Is heavier than the conventional balance knee and also less mobile. Locking is the significant safety feature but knee design offers lesser flexibility and is more analogous to a rigid knee.	The servicing of the knee can be made simpler and more adjustments can be incorporated.

Ottobock 3R67™ Knee		<p>Customised for children this knee offers easy movements, a large flexion angle and a high level of stability support. It is a hydraulic knee with powerful swing phase control and has a large flexion angle. It supports walking, running and outdoor mobility.</p>	<p>Supports limited body weight and is relatively bulky even for lightweight users. The maintenance and product life is again a worry with the product complexity.</p>	<p>As scaling down weight in hydraulic prosthetic knees is a harder goal, it can be improved to support heavier users to cater to a larger scope of users.</p>
Plié® 3 Microprocessor Controlled Knee		<p>This is a microprocessor polycentric knee with interchangeable battery feature. The battery cap is watertight and it offers features such as stance flexion resistance and an integrated alignment guide. Offers customised stumble recovery and also can endure slight water exposure.</p>	<p>Caters only to users with adequate hip strength in flexion and extension. As this is a computerised knee will involve a steep learning curve for the user and also increased servicing requirements which also can never be self tended to.</p>	<p>The water exposure limits can be increased and the reliance on hip strength can be reduced to cater to a wider user profile.</p>
Ottobock C-Leg		<p>The Cockpit app lets you operate the C-Leg directly using your smartphone – Android or iOS – and access information about the joint, such as the battery charge level. Makes precise real-time adjustments helping navigate ramps, stairs, and other rugged surfaces and even walking backwards. Offers an Intuitive Stance feature, which recognizes you have stopped moving and dampens the knee in a slightly flexed position thereby providing stance support.</p>	<p>Cost is very high and compatible only with custom feet which are again on the expensive side. It doesn't offer a replaceable battery feature though the battery life is around 40 hours.</p>	<p>A replaceable battery feature can be provided so that parallel charging of batteries can enable continuous usage.</p>

Using anthropometric data from the slide.

(4.)



Balancing moment about patellofemoral joint.

$$M.F.Q \times d_q = M.F.P \times d_p \\ (\text{Muscle force}) \times d_q = (\text{Patellar tendon force}) \times d_p$$

$$\Rightarrow \frac{M.F.Q}{M.F.P} = \frac{d_p}{d_q} = \frac{18.4}{17.1} = 1.076$$

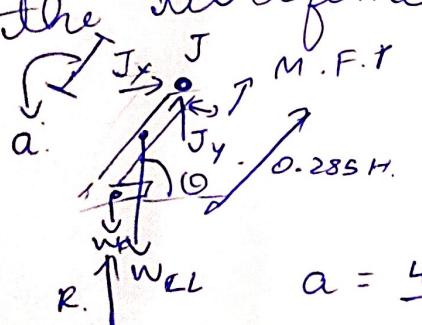
Assuming the leg origination point to be directly above the feet.

$$\Rightarrow 0.285H \times \cos\phi = 0.245 \cos(\phi - 180^\circ)$$

$$\Rightarrow \frac{0.285}{0.245} = \frac{\cos\phi \cos\omega + \sin\phi \sin\omega}{\cos\omega} = \cos\phi + \sin\phi \tan\omega$$

$$\Rightarrow \tan\omega = \tan^{-1} \left[\left(\frac{0.285}{0.245} - \cos\phi \right) \times \frac{1}{\sin\phi} \right]$$

Separating the ~~leg~~ portion below the knee about the tibiofemoral joint (SHANK).



$$R \times 0.285H = W_F \times 0.285H \cos\phi + d_p \times M.F.P$$

$$H + W_F \times \cos\phi$$

$$a = \frac{43.95}{100} \times 0.285H = 0.125H$$

$$W_{EL} = \frac{4.33}{100} \times W = 0.0433W$$

$$W_F = 0.0137W$$

d_p = Value of patellar tendon force moment arm about tibiofemoral joint taken from online source = 49 mm.

Knowns: W, H, Shank Length, Thigh Length, Shank to Thigh Angle (ϕ), Moment Arm Ratios, Patellar Tendon Force Moment Arm, External Load

Unknowns: Patellar Tendon Force, Patellofemoral Joint Reaction, Tibiofemoral Joint Reaction, Quadriceps Force, Theta.

$$\cos(\theta) \cdot \frac{x}{\cancel{0.0433} \cdot 0.125H \cos \theta} = M.F.P.$$

$$= \frac{(W+10) \times 0.285H - (0.0137W) \times 0.285H \cos \theta}{0.049}$$

$$\cancel{F_{xz}} \leq F_x = 0 \Rightarrow J_x = -M.F.P \cos \theta$$

$$\leq F_y = 0 \Rightarrow J_y = W_F + W_{LL} - R = (0.0433 + 0.0137)W - (W+10)$$

$$- MFP \times \sin(\theta)$$

$\frac{-MFP}{\sin(\theta)}$

J_x and J_y are the two perpendicular components of the tibiofemoral joint force.

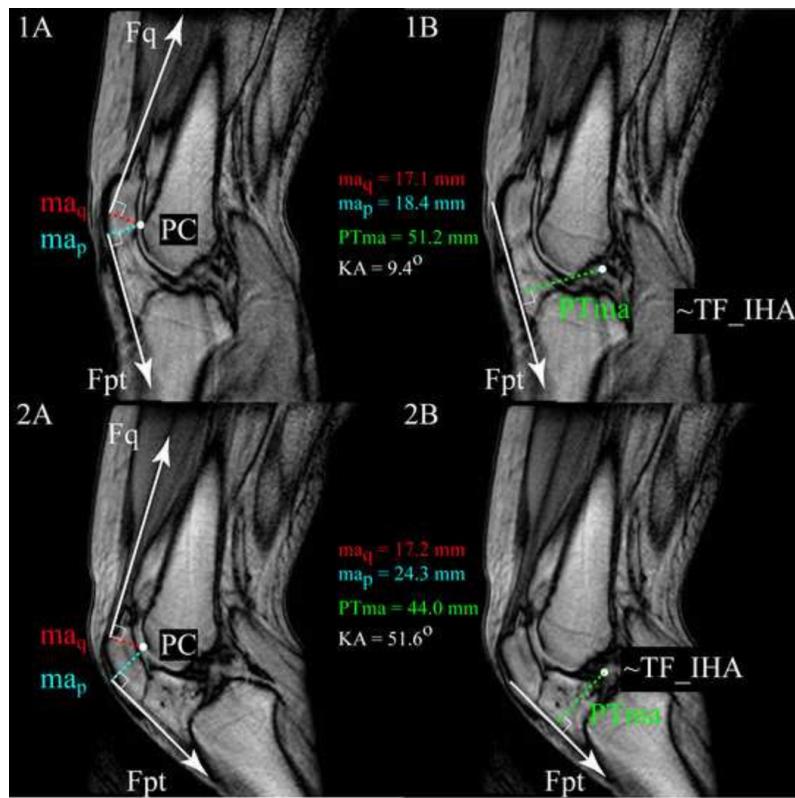
M.F.P \rightarrow patellar tendon force.

Let $\cancel{Q_x}$ be $Q_x \hat{i} + Q_y \hat{j}$ be the patellofemoral joint force. Then,

$$Q_x = M.F.P \cos \theta + M.F.Q \cos(\phi - \theta)$$

$$Q_y = M.F.P \sin \theta - M.F.Q \sin(\phi - \theta)$$

Link used for Moment Arm ratio of Patellar Tendon Force to Quadriceps force about the patellofemoral joint: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662057/>



Link used for finding moment arm of patellar tendon force about tibiofemoral joint:
https://me.queensu.ca/People/Deluzio/JAM/files/6.26.2009_Stacey.pdf

Table 1

Maximum patella tendon moment arm length, the angular position where it occurs and method of calculation as reported in the literature (M: male, F: female)

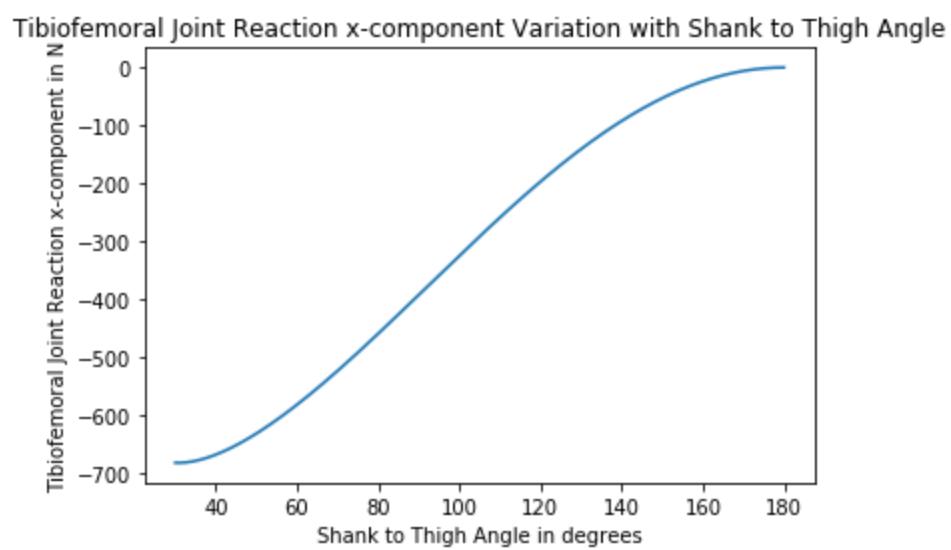
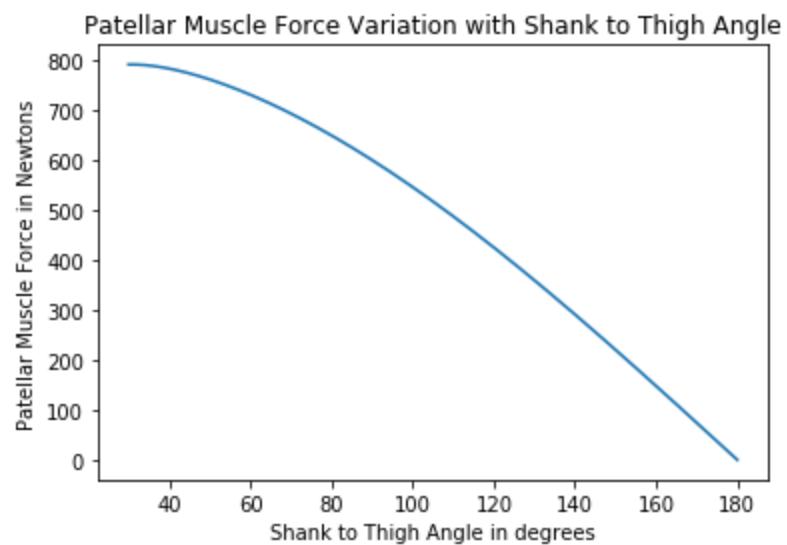
	n	Age	Height (m)	Body mass (kg)	Peak moment arm (mm)	Knee flexion angle (deg)	Method	
Smidt (1973)	26	28	1.76	82	In vivo	49	30	ICR
Krevolin et al. (2004)	6	—	—	—	In vitro	51.9	45	ISA
Imran et al. (2000)	—	—	—	—	2D-model	54	30	IP
Gill and O'Connor (1996)	—	—	—	—	2D-model	41.9	~120	IP
Baltzopoulos (1995)	5	20.8 (SD 3. 9)	1.79 (SD 0.03)	79 (SD 7.2)	In vivo	39.87	45	TFCP
Kellis and Baltzopoulos (1999)	10	23 (SD 1.5)	1.74 (SD 0.04)	74 (SD 3.8)	In vivo	42.6	45	TFCP
Nisell et al. (1986) M	10	27	1.82	75	In vivo	46.2	60	TFCP
Nisell et al. (1986) F	10	23	1.67	59	In vivo	37.9	60	TFCP
Wretenberg et al. (1996) M	10	29 (SD 5)	1.81 (SD 0.06)	79 (SD 7.8)	In vivo	50.8	0	TFCP
Wretenberg et al. (1996) F	7	25 (SD 5)	1.65 (SD 0.03)	60 (SD 6.7)	In vivo	47.1	30	TFCP
Herzog and Read (1993)	5	79.2	—	—	In vitro	52.8	30	TFCP
Lindahl and Movin (1967)	15	—	—	—	In vivo	48	30	TFCP
Yamaguchi and Zazac (1989)	—	—	—	—	2D-model	43	40	TFCP
Lu and O'Connor (1996)	—	—	—	—	2D-model	47.9	40	TFCP
Buford et al. (1997)	15	55.9	—	—	In vitro	51.1	0	TE

The computations were performed for 1500 steps in a python notebook and it can be found in the link below:

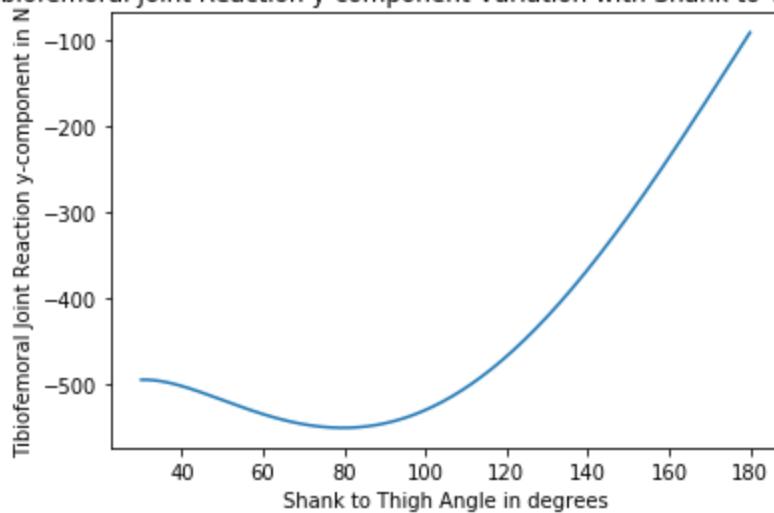
<https://github.com/tarunprasadoff/College/blob/master/MOHM/MOHM%20Endsem%20Question%204.ipynb>

Some of the computed Values:

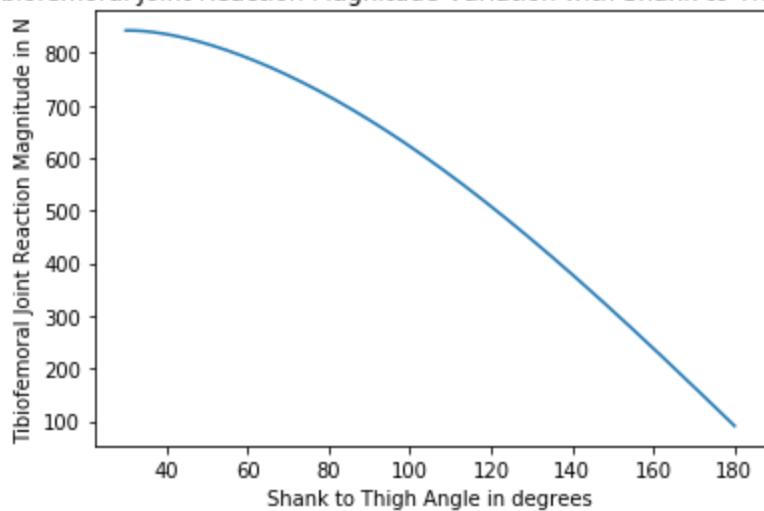
	phi	MFP	Jx	Jy	Jm	Qx	Qy	Qm
0	30.000000	7.920383e+02	-6.808197e+02	-495.831551	842.237714	1.533002e+03	4.156011e+02	1.588339e+03
1	30.100067	7.920551e+02	-6.808485e+02	-495.815897	842.251765	1.533067e+03	4.140670e+02	1.588001e+03
2	30.200133	7.920692e+02	-6.808729e+02	-495.802630	842.263671	1.533122e+03	4.125397e+02	1.587656e+03
3	30.300200	7.920809e+02	-6.808929e+02	-495.791728	842.273453	1.533167e+03	4.110194e+02	1.587305e+03
4	30.400267	7.920900e+02	-6.809086e+02	-495.783172	842.281129	1.533202e+03	4.095058e+02	1.586948e+03
5	30.500334	7.920967e+02	-6.809201e+02	-495.776941	842.286719	1.533228e+03	4.079990e+02	1.586585e+03
6	30.600400	7.921009e+02	-6.809273e+02	-495.773015	842.290240	1.533244e+03	4.064990e+02	1.586216e+03
7	30.700467	7.921027e+02	-6.809303e+02	-495.771375	842.291712	1.533251e+03	4.050056e+02	1.585840e+03
8	30.800534	7.921020e+02	-6.809292e+02	-495.771999	842.291151	1.533249e+03	4.035188e+02	1.585459e+03
9	30.900600	7.920989e+02	-6.809239e+02	-495.774869	842.288578	1.533237e+03	4.020387e+02	1.585071e+03
10	31.000667	7.920935e+02	-6.809145e+02	-495.779963	842.284007	1.533216e+03	4.005651e+02	1.584677e+03
11	31.100734	7.920857e+02	-6.809011e+02	-495.787264	842.277458	1.533185e+03	3.990981e+02	1.584278e+03
12	31.200801	7.920755e+02	-6.808837e+02	-495.796750	842.268947	1.533146e+03	3.976375e+02	1.583873e+03
13	31.300867	7.920631e+02	-6.808622e+02	-495.808403	842.258490	1.533098e+03	3.961834e+02	1.583462e+03
14	31.400934	7.920483e+02	-6.808369e+02	-495.822203	842.246105	1.533041e+03	3.947357e+02	1.583045e+03
15	31.501001	7.920313e+02	-6.808076e+02	-495.838131	842.231807	1.532975e+03	3.932943e+02	1.582622e+03
1485	178.599066	1.041441e+01	-1.177088e-01	-101.511741	101.511809	2.650449e-01	-7.914351e-01	8.346366e-01
1486	178.699133	9.670554e+00	-1.014945e-01	-100.768021	100.768072	2.285352e-01	-7.349454e-01	7.696578e-01
1487	178.799199	8.926694e+00	-8.648106e-02	-100.024275	100.024312	1.947295e-01	-6.784465e-01	7.058394e-01
1488	178.899266	8.182827e+00	-7.266855e-02	-99.280504	99.280531	1.636278e-01	-6.219391e-01	6.431037e-01
1489	178.999333	7.438954e+00	-6.005698e-02	-98.536712	98.536730	1.352303e-01	-5.654239e-01	5.813703e-01
1490	179.099400	6.695075e+00	-4.864639e-02	-97.792898	97.792910	1.095371e-01	-5.089017e-01	5.205567e-01
1491	179.199466	5.951191e+00	-3.843682e-02	-97.049067	97.049074	8.654822e-02	-4.523731e-01	4.605779e-01
1492	179.299533	5.207302e+00	-2.942831e-02	-96.305219	96.305223	6.626374e-02	-3.958388e-01	4.013468e-01
1493	179.399600	4.463409e+00	-2.162087e-02	-95.561357	95.561359	4.868373e-02	-3.392996e-01	3.427745e-01
1494	179.499666	3.719513e+00	-1.501454e-02	-94.817483	94.817484	3.380824e-02	-2.827562e-01	2.847702e-01
1495	179.599733	2.975614e+00	-9.609325e-03	-94.073598	94.073599	2.163732e-02	-2.262092e-01	2.272417e-01
1496	179.699800	2.231712e+00	-5.405255e-03	-93.329706	93.329706	1.217102e-02	-1.696594e-01	1.700954e-01
1497	179.799867	1.487809e+00	-2.402339e-03	-92.585807	92.585807	5.409348e-03	-1.131074e-01	1.132367e-01
1498	179.899933	7.439049e-01	-6.005851e-04	-91.841905	91.841905	1.352338e-03	-5.655406e-02	5.657023e-02
1499	180.000000	5.642105e-14	-3.454793e-30	-91.098000	91.098000	7.172230e-30	-4.289319e-15	4.289319e-15



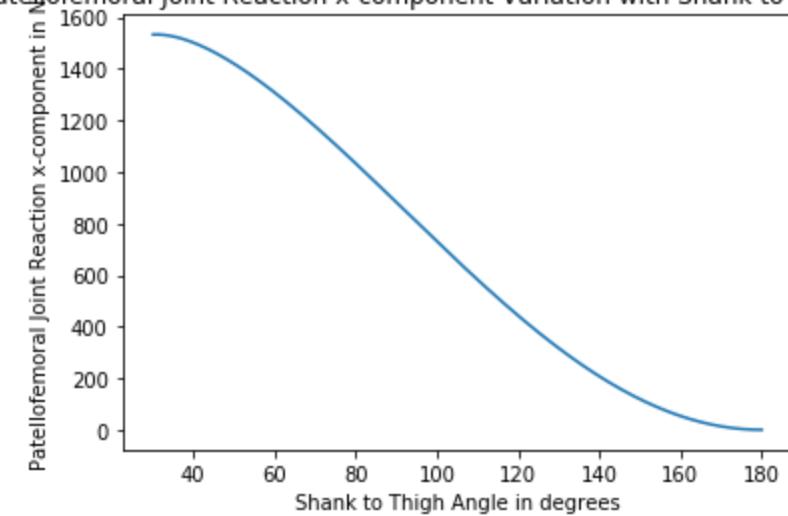
Tibiofemoral Joint Reaction y-component Variation with Shank to Thigh Angle



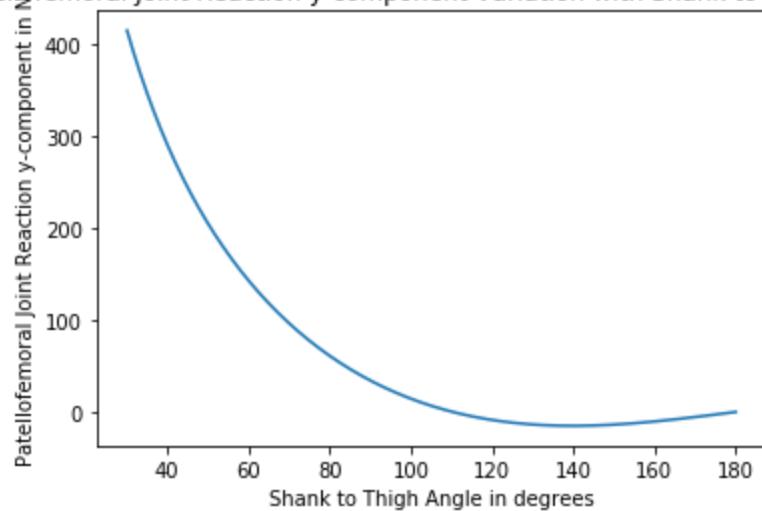
Tibiofemoral Joint Reaction Magnitude Variation with Shank to Thigh Angle



Patellofemoral Joint Reaction x-component Variation with Shank to Thigh Angle



Patellofemoral Joint Reaction y-component Variation with Shank to Thigh Angle



Patellofemoral Joint Reaction Magnitude Variation with Shank to Thigh Angle

