Answer Key

Belts and Roller Chains

exponential LEAP
ONLINE REVIEW

$$St = \frac{F_1}{bt} \quad ; \quad f\theta = 0.30\left(160°\left(\frac{\pi}{180°}\right)\right) = 0.8378$$

$$(F_1 - F_2) = F_1 - F_2\left[\frac{e^{f\theta} - 1}{e^{f\theta}}\right]$$

$$4\,kN = F_1\left[\frac{e^{0.8378} - 1}{e^{0.8378}}\right]$$

$$F_1 = 7.0506\,kN$$

Subst;

$$1.8\,\frac{N}{mm^2} = \frac{7050.6\,N}{(320\,mm)t}$$

$$\boxed{t = 12.2406\,mm}$$

exponential LEAP
ONLINE REVIEW

$$\text{Number of belts} = \frac{\text{Design hp}}{\text{Adjusted hp}}$$

$$\text{Design hp} = \text{Transmitted hp} * \text{service factor}$$

$$= (25\,kw)\left(\frac{1\,hp}{0.746\,kw}\right)(1.30)$$

$$\text{Design hp} = 43.5658\,hp$$

Hence;

$$n = \frac{43.5658\,hp}{5\,hp}$$

$$n = 8.7131$$

$$n = 9\ \text{belts}$$

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Belt length

$$L = \frac{\pi}{2}(D_2 + D_1) + 2c + \frac{(D_2 - D_1)^2}{4c}$$

$$= \frac{\pi}{2}(14\,cm + 8\,cm) + 2(50\,cm) + \frac{(14\,cm + 8\,cm)^2}{4(50\,cm)}$$

$$L = 136.9775\ cm$$

exponential LEAP
ONLINE REVIEW

Angle of contact

$$\phi = \pi - \frac{D_2 - D_1}{C} = \pi - \frac{(18in - 9in)}{75in}$$

$$\phi = (3.0216\ rad)\left(\frac{180°}{\pi}\right)$$

$$\phi = 173.1245°$$

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Belt length

Crossed belt installation

$$L = \frac{\pi}{2}(D_2 + D_1) + 2c + \frac{(D_2 + D_1)^2}{4c}$$

$$= \frac{\pi}{2}(910 + 280)\text{mm} + 2(5000\text{mm}) + \frac{(910 + 280)^2\text{mm}^2}{4(5000\text{mm})}$$

$$L = 11940.0526\text{ mm}$$

$$\boxed{L = 11.940\text{ m}}$$

Angle of wrap

$$\theta = \pi + \frac{D_2 + D_1}{C}$$

$$= \pi + \frac{(910 + 280)\text{mm}}{5000\text{ mm}}$$

$$\theta = (3.3796\text{ rad})\left(\frac{180^\circ}{\pi}\right)$$

$$\boxed{\theta = 193.6364^\circ}$$

exponential LEAP
ONLINE REVIEW

$P = 2\pi TN$; $v = \pi DN$

$30\ \frac{m}{s} = \pi (0.280m) N$

$N = 34.1046\ \frac{rev}{s}$

Subst;

$70\ kw = 2\pi T (34.1046\ rev/s)$

$T = 0.3267\ kN-m$

and;

$\frac{F_1}{F_2} = e^{f\theta} = e^{(0.35)(3.3796\ rad)}$

$F_1 = 3.2637\ F_2$

from;

$T = (F_1 - F_2)\left(\frac{D_1}{2}\right)$

$0.3267\ kN-m = (3.2637\ F_2 - F_2)\left(\frac{0.280m}{2}\right)$

$F_2 = 1.0309\ kN$

$F_1 = 3.3649\ kN$

exponential LEAP
ONLINE REVIEW

$$P = \frac{2\pi T N}{60} \quad ; \quad T = (F_1 - F_2)\frac{D_1}{2} \quad ; \quad v_1 = \frac{\pi D_1 N}{60}$$

$$P = (F_1 - F_2)v$$

$$(30\,hp)\left(\frac{0.746\,kw}{1\,hp}\right) = (3.0\,kN)v$$

$$v = \left(7.46\,m/s\right)\left(\frac{3.28\,ft}{1\,m}\right)$$

$$v = 24.4688\,ft/sec$$

exponential LEAP
ONLINE REVIEW

$$S_d = \frac{F_1}{bt} \quad ; \quad \frac{F_1}{F_2} = e^{f\theta} = e^{(0.30)(160°)\left(\frac{\pi}{180°}\right)}$$

$$F_1 = 2.3112\, F_2$$

and;

$$F_1 - F_2 = 4\ \text{kN}$$

$$2.3112\, F_2 - F_2 = 4\ \text{kN}$$

$$F_2 = 3.0506\ \text{kN}$$

$$F_1 = 7.0506\ \text{kN}$$

Hence;

$$2.1\ \text{MPa} = \frac{7.0506\ \text{kN}\left(\frac{1000\ \text{N}}{1\ \text{kN}}\right)}{(400\ \text{mm})\, t}$$

$$\boxed{t = 8.3936\ \text{mm}}$$

exponential LEAP
ONLINE REVIEW

$$P = \frac{2\pi TN}{60}$$

$$60\,kW = \frac{2\pi T(650\,rpm)}{60}$$

$$T = 0.8815\,kN\text{-}m$$

Then;

$$T = (F_1 - F_2)\frac{D_1}{2}$$

$$0.8815\,kN\text{-}m = (F_1 - F_2)\left(\frac{0.580\,m}{2}\right)$$

$$F_1 - F_2 = 3.0396\,kN$$

exponential LEAP
ONLINE REVIEW

$$\theta = \pi - \frac{D_2 - D_1}{C}$$

$$= \pi - \frac{(35 - 12)\,cm}{60\,cm}$$

$$\theta = (2.7583\ rad)\left(\frac{180^\circ}{\pi\ rad}\right)$$

$$\boxed{\theta = 158.0366^\circ}$$

exponential LEAP
ONLINE REVIEW

$P = (F_1 - F_2)v$; $T = (F_1 - F_2)\frac{D_1}{2}$

$5\,kN\text{-}m = (F_1 - F_2)\left(\frac{0.310\,m}{2}\right)$

$F_1 - F_2 = 32.2581\,kN$

Substitute:

$P = (32.2581\,kN)\left(25\,\frac{m}{s}\right)$

$P = 806.4516\,kW$

exponential LEAP
ONLINE REVIEW

$$D_1 N_1 = D_2 N_2$$

$$(10\text{cm})(650\text{rpm}) = (24\text{cm})N_2$$

$$N_2 = (270\text{ rpm})(1-0.06)$$

$$N_2 = 253.80\text{ rpm}$$

exponential LEAP
ONLINE REVIEW

$$L = \frac{\pi}{2}(D_2 + D_1) + 2c + \frac{(D_2 - D_1)^2}{4c}$$

$$= \frac{\pi}{2}(10+5)\text{cm} + 2(75\text{cm}) + \frac{(10+5)^2\text{cm}^2}{4(75\text{cm})}$$

$$\boxed{L = 174.3119\ \text{cm}}$$

exponential LEAP
ONLINE REVIEW

$$\theta = \pi - \frac{D_2 - D_1}{c}$$

$$= \pi - \frac{(14 - 7)\text{in}}{73\text{ in}}$$

$$\theta = (3.0457\text{ rad})\left(\frac{180^\circ}{\pi}\right)$$

$$\boxed{\theta = 174^\circ}$$

exponential LEAP
ONLINE REVIEW

$$P = \frac{2\pi T N}{33000}(S.F.)$$

$$\left(\frac{15\,hp}{strand}\right)(3\,strands) = \frac{2\pi T(650\,rpm)}{33000}(1.6)$$

$$T = 242.4052\ ft\text{-}lb$$

exponential LEAP
ONLINE REVIEW

$$T_1 N_1 = T_2 N_2$$

$$(24 \text{ teeth})(1600 \text{ rpm}) = T_2 (600 \text{ rpm})$$

$$T_2 = 64 \text{ teeth}$$

exponential LEAP
ONLINE REVIEW

$$C = \frac{P}{\theta}\left[2L - T_2 - T_1 + \sqrt{(2L - T_2 - T_1)^2 - \frac{8}{\pi^2}(T_2 - T_1)^2}\right]$$

solving for L in pitches

$$L = \frac{(75\,in)}{(3/4\,in)} = 100 \text{ pitches}$$

$$C = \frac{0.75\,in}{8}\left[2(100) - 48 - 12 + \sqrt{[(2)(100) - 48 - 12]^2 - \frac{8}{\pi^2}(48 - 12)^2}\right]$$

$C = 25.8934$ inches

exponential LEAP
ONLINE REVIEW

$$C = D_2 + \frac{D_1}{2}$$

$$(50 \text{ pitches})\left(\frac{3}{4} \text{ in}\right) = D_2 + \left(\frac{9 \text{ in}}{2}\right)$$

$$D_2 = 33 \text{ in}$$

exponential LEAP
ONLINE REVIEW

$$L = 2C + \frac{T_2 + T_1}{2} + \frac{(T_2 - T_1)^2}{4\pi^2 C}$$

$$= 2(38) + \frac{100 + 20}{2} + \frac{(100 - 20)^2}{4\pi^2 (38)}$$

$$L = 140.26 \text{ pitches}$$

exponential LEAP
ONLINE REVIEW

$$C = D_2 + \frac{D_1}{2}$$

$$= 18\text{in} + \frac{6\text{in}}{2}$$

$$\boxed{C = 21\text{ in}}$$

exponential LEAP
ONLINE REVIEW

$$V_1 = \frac{\pi D_1 N_1}{60}$$

$$\left(900 \frac{ft}{min}\right)\left(\frac{1 min}{60 sec}\right) = \frac{\pi D_1 (1000 rpm)}{60}$$

$$D_1 = (0.2865 ft)\left(\frac{12 in}{1 ft}\right) = 3.4377 in$$

$$D = \frac{P}{\sin\left(\frac{180°}{T}\right)}$$

$$3.4377 in = \frac{3/4 in}{\sin\left(\frac{180°}{T}\right)}$$

$$\frac{180°}{T} = 12.6015°$$

$$T = 14.2840$$

$$T = 14 \text{ teeth}$$

exponential LEAP
ONLINE REVIEW

$$HP = (6\,hp)(1.20)$$

$$\boxed{HP = 7.2\,hp}$$

exponential LEAP
ONLINE REVIEW

$$D = \frac{P}{\sin\left(\frac{180^\circ}{T}\right)}$$

$$30_{in} = \frac{P}{\sin\left(\frac{180^\circ}{90}\right)}$$

$$P = 1.0469 \text{ in}$$

exponential LEAP
ONLINE REVIEW

$$D = \frac{P}{\sin\left(\frac{180^\circ}{T}\right)}$$

$$9.56\,in = \frac{1/2\,in}{\sin\left(\frac{180^\circ}{T}\right)}$$

$$T = 60.0398$$

$$T = 60\ teeth$$

exponential LEAP
ONLINE REVIEW

$$v = \frac{PTN}{60} = \frac{(3/4\ in)(24\ teeth)(620\ rpm)}{60}$$

$$v = \left(186\ \frac{in}{sec}\right)\left(\frac{1\ ft}{12\ in}\right)$$

$$v = 15.5\ ft/sec$$

exponential LEAP
ONLINE REVIEW

$$D = \frac{P}{\sin\left(\frac{180°}{T}\right)} = \frac{3/4\ in}{\sin\left(\frac{180°}{20}\right)}$$

$$D = 4.7943\ in$$