Answer Key

Spur gears

1 to 2

$$m = \frac{D\,(mm)}{T}$$

for the pinion

$$3 = \frac{D_1}{20\ teeth}$$

$$D_1 = 60\,mm$$

for the Gear

$$3 = \frac{D_2}{30\ teeth}$$

$$D_2 = 90\,mm$$

Center DISTANCE Between Gears

$$C = \frac{D_1 + D_2}{2} = \frac{60\,mm + 90\,mm}{2}$$

$$C = 75\,mm$$

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

$$50\,kW = \frac{2\pi T(580\,rpm)}{60}$$

$$T = 0.8232\ kN\text{-}m$$

Hence;

$$T = F\left(\frac{D}{2}\right)$$

$$0.8232\ kN\text{-}m = F\left(\frac{0.220m}{2}\right)$$

$$\boxed{F = 7.4838\ kN}$$

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

$$30\,kW = \frac{2\pi T(850\,rpm)}{60}$$

$$T = 0.3370\ kN\text{-}m$$

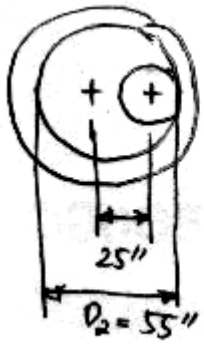
Hence;

$$T = F\left(\frac{D}{2}\right)$$

$$D = (12\,in)\left(\frac{25.4\,mm}{1\,in}\right)\left(\frac{1\,m}{1000\,mm}\right) = 0.3048\ m$$

$$0.3370\,kN\text{-}m = F\left(\frac{0.3048\,m}{2}\right)$$

$$\boxed{F = 2.2113\ kN}$$



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

$$25\,in = \frac{55\,in - D_1}{2}$$

$$D_1 = 5\,in$$

OUTSIDE Diameter

$P_d = 6$

$D = 10\,in$

$D_o = D + 2a \;;\quad a = \frac{1}{P_d}$

$= 10\,in + 2\left(\frac{1}{6\,in}\right)$

$D_o = 10.3333\,in$

$D_o = 10 - \frac{1}{3}\,in$

$$t = \frac{\pi}{2P_d}$$

$$0.130\,in = \frac{\pi}{2P_d}$$

$$P_d = 5.2359\,g$$

Hence;

$$a = \frac{1}{P_d} = \frac{1}{5.2359\,g}$$

$$a = 0.1909\,g\,in$$

$$t = \frac{\pi}{2P_d}$$

$$0.20 = \frac{\pi}{2P_d}$$

$$P_d = 7.85398$$

Hence;

$$a = \frac{1}{P_d} = \frac{1}{7.85398}$$

$$a = 0.1273 \text{ in}$$

$$m = \frac{D\,(25.4)}{T} \quad ; \quad P_d = \frac{T}{D}$$

$$m = \frac{25.4}{P_d}$$

$$3 = \frac{25.4}{P_d}$$

$$P_d = 8.4667 \text{ in}$$

Working Depth

$$WD = a + b$$

$$P_c P_d = \pi$$

$$(0.785\ in) P_d = \pi$$

$$P_d = 4.0$$

$$a = \frac{1}{P_d} = \frac{1}{4} = 0.25\ in$$

$$b = \frac{1.157}{P_d} = \frac{1.157}{4} = 0.28925\ in$$

Hence;

$$WD = (0.25 + 0.28925)\ in$$

$$\boxed{WD = 0.53925\ in}$$

$$V = \frac{\pi D N}{60} \quad ; \quad m = \frac{D\,(mm)}{T}$$

$$3 = \frac{D}{42\ teeth}$$

$$D = 126\ mm$$

Hence,

$$2600\ \frac{mm}{sec} = \frac{\pi\,(126\ mm)N}{60}$$

$$N = 394.0979\ rpm$$

$$v = \frac{\pi DN}{60} \quad ; \quad P_c = \frac{\pi D}{T}$$

$$0.785\ in = \frac{\pi D}{30\ teeth}$$

$$D = 7.4962\ in$$

Hence;

$$\left(15\ \frac{ft}{sec}\right)\left(\frac{12\ in}{1\ ft}\right) = \frac{\pi (7.4962\ in) N}{60}$$

$$N = 458.5986\ rpm$$

$$P_c P_d = \pi$$

$$1.60\, P_d = \pi$$

$$P_d = 1.9635 \text{ in}$$

Hence;

$$P_d = \frac{T}{D}$$

$$1.9635 = \frac{42 \text{ teeth}}{D}$$

$$D = 21.3904 \text{ in}$$

$$P_D = \frac{T-2}{P_d} \quad ; \quad m = \frac{25.4}{P_d}$$

$$5.2778 = \frac{25.4}{P_d}$$

$$P_d = 4.8126 \text{ in}$$

subst;

$$(190\text{mm})\left(\frac{1\text{in}}{25.4\text{ mm}}\right) = \frac{T+2}{4.8126}$$

$$T = 34 \text{ teeth}$$

$$VR = \frac{N_1}{N_2} = \frac{D_2}{D_1} = \frac{T_2}{T_1}$$

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

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

$$2.8\text{ in} = \frac{D_1 + 2D_1}{2}$$

$$D_1 = 1.8667\text{ in}$$

then;

$$P_d = \frac{T_1}{D_1}$$

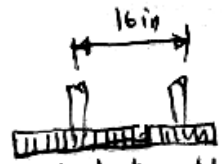
$$10.7140 = \frac{T_1}{1.8667}$$

$$T_1 = 20\text{ teeth}$$

$$D_o = \frac{T+2}{P_d}$$

$$\left(5\tfrac{1}{3}\ in\right) = \frac{T+2}{6}$$

$$T = 30\ teeth$$



$T_2 = 42$ teeth $N_1 = 160$ rpm
$P_d = 2$

$$VR = \frac{N_1}{N_2} = \frac{D_2}{D_1} = \frac{T_2}{T_1}$$

$$P_d = \frac{T_2}{D_2}$$

$$2 = \frac{42 \text{ teeth}}{D_1}$$

$$D_2 = 21 \text{ in}$$

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

$$16 \text{ in} = \frac{21 \text{ in} + D_2}{2} \qquad 16 \text{ in} = \frac{D_1 + 21 \text{ in}}{2}$$

$$D_1 = 11 \text{ in}$$

Hence;

$$\frac{160 \text{ rpm}}{N_2} = \frac{21 \text{ in}}{11 \text{ in}}$$

$$N_2 = 83.8095 \text{ rpm}$$

$$VR = \frac{4}{1} \quad ; \quad VR = \frac{T_2}{T_1}$$

$$4 = \frac{40 \text{ teeth}}{T_1}$$

$$T_1 = 10 \text{ teeth}$$

$$P_d = \frac{T}{D}$$

$$5 = \frac{30\ \text{teeth}}{D}$$

$$D = 15\ \text{in}$$

$$C = \frac{D_1 + D_2}{2} \quad ; \quad P_d = \frac{T_1}{D_1} \qquad P_d = \frac{T_2}{D_2}$$

$$8 = \frac{14 \text{ teeth}}{D_1} \qquad 8 = \frac{38 \text{ teeth}}{D_2}$$

$$D_1 = 1.75 \text{ in} \qquad D_2 = 4.75 \text{ in}$$

Hence;

$$C = \frac{(1.75 + 4.75)\text{in}}{2}$$

$$\boxed{C = 3.25 \text{ in}}$$

$$P_c = \pi \frac{D}{T} \quad ; \quad C = \frac{D_1 + D_2}{2} \quad ; \quad P_d = \frac{T_1}{D_1} \quad ; \quad P_d = \frac{T_2}{D_2}$$

$$P_c P_d = \pi$$

$$C = \frac{(T_1/P_d) + (T_2/P_d)}{2} = \frac{T_1 + T_2}{2 P_d}$$

$$12\ in = \frac{(24 + 56)\ teeth}{2 P_d}$$

$$P_d = 3.3333$$

Hence;

$$P_c(3.3333) = \pi$$

$$\boxed{P_c = 0.9425\ in}$$

22 to 25

$$V.R = \frac{N_1}{N_2} = \frac{D_2}{D_1} = \frac{T_2}{T_1}$$

$$C = \frac{D_1 + D_2}{2} = \frac{D_1 + VRD_1}{2} = \frac{D_1(1 + VR)}{2}$$

$$18 = \frac{D_1(1 + 10/8)}{2}$$

$D_1 = 16$ in

$D_2 = 20$ in

Number of teeth

For the pinion

$$P_d = \frac{T_1}{D_1}$$

$$9 = \frac{T_1}{16\text{ in}}$$

$T_1 = 144$ teeth

For the Gear

$$P_d = \frac{T_2}{D_2}$$

$$9 = \frac{T_2}{20\text{ in}}$$

$T_2 = 180$ teeth

22 to 25 cont…

OUTSIDE Diameter

for the pinion

$$D_{o_1} = \frac{T_1 + 2}{P_d} = \frac{144 + 2}{9}$$

$$D_{o_1} = 16.2222 \text{ in}$$

for the Gear

$$D_{o_2} = \frac{T_2 + 2}{P_d} = \frac{180 + 2}{9}$$

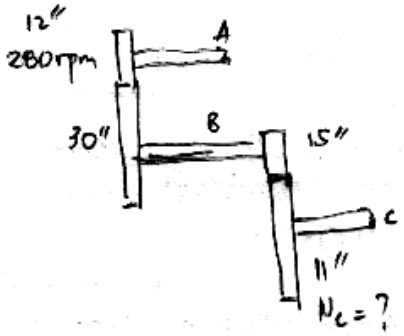
$$D_{o_2} = 20.2222 \text{ in}$$

CIRCULAR PITCH

$$P_c P_d = \pi$$

$$P_c (9) = \pi$$

$$P_c = 0.3491 \text{ in}$$



$$D_A N_A = D_B N_B$$

$$(12in)(280rpm) = (30in) N_B$$

$$N_B = 112 \text{ rpm}$$

$$D_B N_B = D_C N_C$$

$$(15in)(112rpm) = (11in) N_C$$

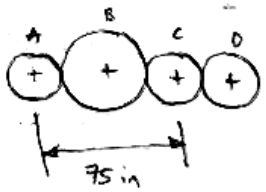
$$N_C = 152.7273 \text{ rpm}$$

TANGENTIAL VELOCITY

$$v_t = \pi D_1 N_1$$

$$\left(80 \frac{\text{ft}}{\text{min}}\right)\left(\frac{12\,\text{in}}{1\,\text{ft}}\right) = \pi (12\,\text{in}) N_1$$

$$N_1 = 25.4648 \text{ rpm}$$



$A:B:C:D = 6:4:2:5$

$D_A N_A = D_C N_C$

$D_A(6) = D_C(2)$

$D_A = D_C\left(\frac{1}{3}\right)$

$D_B N_B = D_C N_C$

$D_B(4) = D_C(2)$

$D_B = D_C\left(\frac{1}{2}\right)$

then;

$C_{AC} = \frac{D_A}{2} + D_B + \frac{D_C}{2} = 75\text{ in}$

$75\text{ in} = \frac{D_C}{6} + \frac{D_C}{2} + \frac{D_C}{2}$

$D_C = 64.2857\text{ in}$

And;

$D_C N_C = D_D N_D$

$(64.2857\text{ in})(2) = D_D(5)$

$D_D = 25.7143\text{ in}$

Internal Gears

$$VR = \frac{N_1}{N_2} = 2.8 \quad ; \quad C = \frac{D_2 - D_1}{2}$$

$$N_1 = 2.8 N_2$$

and;

$$D_1 N_1 = D_2 N_2$$

$$D_1 (2.8 N_2) = D_2 N_2$$

$$D_2 = 2.8 D_1$$

Hence;

$$(60\,cm)\left(\frac{1\,in}{2.54\,cm}\right) = \frac{2.8 D_1 - D_1}{2}$$

$$D_1 = 26.2467\,in$$

$$D_2 = 73.4908\,in$$

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

$$VR = \frac{N_1}{N_2} = 3.5$$

$$N_1 = 3.5 N_2$$

from;

$$D_1 N_1 = D_2 N_2$$

$$D_1 (3.5 N_2) = D_2 N_2$$

$$D_2 = 3.5 D_1 = 3.5 (12 in)$$

$$D_2 = 42 in$$

Hence;

$$C = \frac{(12 + 42) in}{2}$$

$$\boxed{C = 27 in}$$

$$VR = \frac{N_1}{N_2} \quad ; \quad N_2 = \frac{N_1}{VR}$$

$$V_2 = \pi D_2 N_2$$

$$= \pi (0.820\,m)\left(\frac{3.29\,ft}{1\,m}\right)\left(\frac{1500\,rev}{1.5\,min}\right)\left(\frac{1\,min}{60\,sec}\right)$$

$$V_2 = 140.8271\ ft/sec$$