5. a) $\tau_{vmax} = \frac{T}{W_v}$ (TS, s 18)

$W_v = \frac{\pi D^3}{16}$ (TS, s 19) $\quad T = M_v = 38{,}5\ Nm \quad D = 12{,}7\ mm$

$\tau_{vmax} = \frac{T}{W_v} = \frac{T}{\left(\frac{\pi D^3}{16}\right)} = \frac{16T}{\pi D^3} = \frac{16 \cdot 38{,}5 \cdot 10^3}{\pi \cdot 12{,}7^3} = 95{,}7\ MPa \approx \underline{96\ MPa}$ (Nm → Nmm)

b) $\theta = \frac{M_v \cdot L}{G \cdot I_p}$ (TS, s 18)

$M_v = 38{,}5\ Nm$, $L = 154\ mm$, $G = 8{,}1 \cdot 10^4\ MPa$ (N/mm^2) (TS, s 27)

$I_p = \frac{\pi D^4}{32}$

$\theta = \frac{M_v \cdot L}{G \cdot I_p} = \frac{M_v L \cdot 32}{G \cdot \pi D^4} = \frac{38{,}5 \cdot 10^3 \cdot 154 \cdot 32}{8{,}1 \cdot 10^4 \cdot \pi \cdot 12{,}7^4} = 28{,}66 \cdot 10^{-3} = \underline{0{,}0287\ rad}$ (Nm → Nmm)

c) $1\ rad = \frac{180°}{\pi}$ (s 5 i TS)

$\theta = 0{,}02866\ rad = 0{,}02866 \cdot \frac{180°}{\pi} = \underline{1{,}64°}$

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6. a) $M_v = 9{,}55 \cdot \frac{P}{n} \iff P = \frac{M_v n}{9{,}55} = \frac{215 \cdot 2900}{9{,}55} = 65287\ W$

$\approx \underline{65{,}3\ kW}$

b) $P = 65{,}3\ kW = 87{,}6\ hp$

$1\ hp = 745{,}7\ W = 0{,}7457\ kW$

$1\ kW = \frac{1}{0{,}7457}\ hp$

$1 hp \neq 1 hk$

$1\ hk = 735{,}5\ W = 0{,}7355\ kW$

$1\ kW = \frac{1}{0{,}7355}\ hk$

$P = \frac{65{,}3}{0{,}7355}\ hk = 88{,}78\ hk \approx \underline{89\ hk}$

c) $\tau_{v\,max} = \frac{T}{W_v}$, $W_v = \frac{\pi D^3}{16}$

$\tau_{vmax} = \frac{T \cdot 16}{\pi \cdot D^3} \Rightarrow D^3 = \frac{16 \cdot T}{\pi \cdot \tau_{vmax}} \Rightarrow D = \sqrt[3]{\frac{16 \cdot 215 \cdot 10^3}{\pi \cdot 65}}$

$= 25{,}64\ mm$

$= \underline{26\ mm}$

7. SS-stål 1650-00 : $R_{eL} = 270$ MPa ($63\text{mm} < D < 150\text{mm}$)

$$\sigma_{till} = \frac{R_{eL}}{n_s} = \frac{270}{2,2} = 122,7 \text{ MPa}$$

$$\tau_{till} = 0,6 \cdot \sigma_{till} = 0,6 \cdot 122,7 = 73,6 \text{ MPa}$$

$$\tau_{vmax} = \tau_{till}$$

$$\tau_{vmax} = \frac{T}{W_v} \quad , \quad W_v = \frac{\pi D^3}{16}$$

(s 18 i TS)

$$\tau_{vmax} = \frac{16T}{\pi D^3} \Leftrightarrow D^3 = \frac{16T}{\pi \tau_{vmax}} \Rightarrow D = \sqrt[3]{\frac{16 \cdot 220 \cdot 10^3}{\pi \cdot 73,6}} = 24,8 \text{ mm}$$

(s 19 i TS)

$\Rightarrow R_{eL} = 310$ MPa ($16\text{mm} < D < 40\text{mm}$)

$$\tau_{till} = 0,6 \cdot \sigma_{till} = 0,6 \cdot \frac{R_{eL}}{n_s} = 0,6 \cdot \frac{310}{2,2} = 84,5 \text{ MPa}$$

$$D = \sqrt[3]{\frac{16 \cdot 220 \cdot 10^3}{\pi \cdot 84,5}} = 23,67 \approx \underline{24 \text{ mm}}$$

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8. a) $M_v = \underbrace{\frac{30}{\pi}}_{9,55} \cdot \frac{P}{n_m} \Leftrightarrow P = M_v \cdot n_m \cdot \frac{\pi}{30} = 183 \cdot 1950 \cdot \frac{\pi}{30} = \underline{37,4 \text{ kW}}$ (s 18 i TS)

b) $n_d = \frac{n_m}{13,4} = \frac{1950}{13,4} = 145,5 \approx \underline{146 \text{ varv/minut}}.$

c) $M_v = \frac{30}{\pi} \cdot \frac{P}{n_d} = \frac{30}{\pi} \cdot \frac{37,4 \cdot 10^3}{145,5} = 2454 \text{ Nm} \approx \underline{2,45 \text{ kNm}}$ (s 7 i TS)

d) $\eta = \frac{P_{ut}}{P_{in}} \Rightarrow P_{ut} = \eta P_{in} \Rightarrow M_{vut} = \eta M_{vin} = 0,95 \cdot 2454$

$= 2332 = \underline{2,33 \text{ kNm}}$
