1. Estimate the power transmission capacity of a muff coupling having shaft diameter of 80 mm , muff diameter of 150 mm rotating at 150 rpm . $[\tau]_{shaft}$ = 50 N/mm^2. $[\tau]_{muf}$ =10 N/mm^2

SOLUTION:-

- d = 80 mm
- D = 150mm
- N = 150 rpm
- $[\tau]_{shaft}$ = 50 N/mm^2
- $[\tau]_{muf}$ =10 N/mm^2
- P = ????

$$M_t = \frac{\pi}{16} d^3 \times [\tau]$$

= (pie/16)*80^3*50

= 5.02*10^6 N*mm

M_t =5.02*10^3 N*m

POWER P $$P = \frac{2\pi N M_t}{60 \times 10^3}$$

= 2*PIE*5.02*10^3*150/60

= 78.85 * 10^3 watt

= 78.85 KW

$$P = \frac{2\pi N M_t}{60\times10^3}$$ $5.02*10^6$

2. A hollow shaft having 230 mm and 310 mm internal and external diameter respectively rotates at 120 rpm and transmits 30hp. Determine the stresses induced in the shaft.

Solution:-

- D = 310 mm
- d= 230 mm
- N =120 RPM
- P = 30 HP = 30*0.746 = 22.38 KW
- τ = ????

1. Torque:-

$$M_t = \frac{KW\times10^6\times60}{2\pi N} \quad (N.mm)$$

$= 22.38 * 10^6*60/(2 \pi*120)$

$= 1780943.81\ N*mm$

2. Shear stress:-

$$M_t = \frac{\pi}{16}\left[\frac{D^4 - d^4}{D}\right]\times[\tau]$$

$\tau = M_t * 16*D/(\pi*(D^4 - d^4))$

$= 1780943.81 *16*310/(\pi*(310^4-230^4)$

$=0.33\ N/mm^2$

3. A flange coupling transmit 15 Kw power at 200 rpm.Maximum torque is 25 % higher than full load torque. Determine the diameter of shaft and number of bolts. $[\tau]$shaft = 40 N/mm^2.

Solution:

- P = 15 KW
- N = 200 RPM
- $T_{max} = T + 25\%T = 1.25*T$
- d, n = ????

1. Find shaft dia;-

$$M_t = \frac{KW\times10^6\times60}{2\pi N}\ (N.mm)$$

$=15*10^6* 60/(2\pi*200)$

$= 716.19*10^3\ N*mm$

$T_{max} = 1.25*T$

$= 1.25*716.19*10^3$

$= 895.24*10^3$ N*mm

$$M_t = \frac{\pi}{16} \times d^3 \times [\tau]_{shaft}$$

$d^3 = 16* T_{max}/(\pi * \tau_{shaft})$

$= 16*895.24*10^3/(40\pi)$

$d^3 = 113.98*1000$ mm

$= 48.46$ mm

$= 50$ mm

2. No. of bolt

$n = 0.02d + 3$

$= 0.02*50 + 3$

$n = 4$

4. Find the diameter for the 4 bolts of a flange coupling to transmit 60kW at 300rpm. The pitch circle diameter of bolt is 300mm. The allowable shear stress

for bolt is 25MPa. Assume maximum torque to be 25% greater than full load torque.

Solution:-

- $n = 4$
- $P = 60$ KW
- $N = 300$ RPM
- $D_p = 300$ mm
- $[\tau]_{bolt} = 25$ MPa $= 25$ N/mm^2
- $T_{max} = 1.25*T$
- d_b = ?????

1. Find Torque;-

$$M_t = \frac{KW \times 10^6 \times 60}{2\pi N} \; (N.mm)$$

$= 60*10^6* 60/(2 \pi*300)$

$= 1.90*10^6$ N*mm

$T_{max} = 1.25*T$

$= 1.25*1.90*10^6$

$= 2.375*10^6$ N*mm

2. Dia of bolt:-

$$[M_t] = \frac{\pi}{4} \times d_b^2 \times [\tau]_{bolt} \times n \times \frac{D_P}{2}$$

$$\therefore d_b = \left[\frac{8 \times [M_t]}{\pi \times [\tau]_{bolt} \times n \times D_P} \right]$$

$=8*2.375*10^6/(\pi*25*4*300)$

d_b = 14.19 mm

= 16 mm

5. A simple flange coupling has to transmit 40 KW at 450 RPM. Assume torque to be 25 % more than the full load. Calculate (a) Shaft diameter (b) Key Dimensions and (c) number & size of Bolts. The stresses are as under, For Shaft & Key σ = 100 N/mm2, τ = 50 N/mm2&τc= 75 N/mm2 For Bolt τb = 40 N/mm2.

SOLUTION:

- P = 40 KW
- T_{max} = 1.25*T
- N = 450 RPM
- σ = 100 N/mm^2(shaft & key)
- τ = 50 N/mm2 (shaft & key)
- τ_b = 40 N/mm2

- d, L, W, t, n, d_b = ?????

1. FIND SHAFT DIAMETER (d):-

$$M_t = \frac{KW \times 10^6 \times 60}{2\pi N} \; (N.mm)$$

$= 40*10^6*60/(2^{\pi*450})$

$= 848.82*10^3$ N*mm

$T_{max} = 1.25*T$

$= 1.25*848.82*10^3$

$= 1.06*10^6$ N*mm

$$M_t = \frac{\pi}{16} \times d^3 \times [\tau]$$

$d^3 = 16* T_{max}/(3.14* \tau_{shaft})$

$= 16*1.06*10^6/(3.14*50)$

d = 47.62 mm

d = 48 mm

2. KEY DIMENSIONS:-

- L = 1.57d = 1.57*48 = 75.36mm = 76mm
- W = d/4 = 48/4 = 12 mm
- T = d/6 = 48/6 = 8 mm

3. BOLT DIMENSIONS :-

- Pitch circle diameter $D_1 = D_p = 3d$ = 3* 48 = 144 mm
- **No of bolt n = 0.02d + 3 = 0.02*48 + 3 = 3.96 =4 nos.**
- Diameter of bolt d_b :

$$[M_t] = \frac{\pi}{4} \times d_b{}^2 \times [\tau]_{bolt} \times n \times \frac{D_P}{2}$$

- $$\therefore d_b = \left[\frac{8 \times [M_t]}{\pi \times [\tau]_{bolt} \times n \times D_P} \right]$$

= $8*1.06*10^6$ /(3.14*40*4*144)

= 10.82 mm

d_b = 12 mm

6. A C.I. flange coupling is required to transmit 15 kW at 900 R.P.M. Find shaft diameter 'd', hub diameter 'D', no. of bolts 'n' and bolt diameter 'db'. Permissible stresses - shear [τ] for shaft and bolt material = 40 Mpa and crushing stress for bolt material = 80 Mpa and shear stress for C.I. flange material [τ] = 8 MPa.

1.FIND SHAFT DIAMETER (d):-

$$M_t = \frac{KW \times 10^6 \times 60}{2\pi N} \quad (N.mm)$$

= $15*10^6*60/(2\pi*900)$

= $159.15*10^3$ N*mm

$$M_t = \frac{\pi}{16} \times d^3 \times [\tau]$$

$d^3 = 16 * T_{max} / (3.14 * \tau_{shaft})$

$= 16 * 159.15 * 10^3 / (3.14 * 40)$

$d = 27.26$ mm

d = 28 mm

3. FIND HUB DIAMETER (D):-

D = 2d = 2*28 = 56 mm

$$M_t = \frac{\pi}{16} \left[\frac{D^4 - d^4}{D}\right] \times [\tau]$$

$\tau_{hub} = 16 * M_t * D / (3.14(D^4 - d^4))$

$= 16 * 159.15 * 10^3 * 56 / (3.14(56^4 - 28^4))$

$= 4.92\ N/mm^2$

If, $\tau_{hub} \leq [\tau_{hub}]$ then design is safe

4. BOLT DIMENSIONS :-

- Pitch circle diameter $D_1 = D_p = 3d = 3 * 28 = 84$ mm
- **No of bolt n = 0.02d + 3 = 0.02*28+ 3 = 3.56 =4 nos.**
- Diameter of bolt d_b :

$$[M_t] = \frac{\pi}{4} \times d_b^{\,2} \times [\tau]_{bolt} \times n \times \frac{D_P}{2}$$

- $$\therefore d_b = \left[\frac{8 \times [M_t]}{\pi \times [\tau]_{bolt} \times n \times D_P} \right]$$

= $8*159.15*10^3/(3.14*40*4*84)$

= 5.49 mm

d_b = 6 mm