Mechanical Eng. Dept.
ME 352

Taibah University
College of Engineering

Mechanical Design II
March 2020
Mid. Term Exam
Time allowed: 1 hr.

Problem (1)

(A) Choose the correct answer:

a- Helical gears are:
1– has low working noise than spur gears
2- has high working noise than spur gears
3- same noise as spur gears

b- Gear module equals:
1- N/d where N is number of teeth and d is the pitch circle diameter
2- d/N
3- d x N

c- Rigidity of shafts is related to :
1- Resulted stresses
2- Resulted lateral defection
3- Resulted twisting angle

d- Rolling bearings can sustain:
1- Bending and reaction forces
2- Reaction forces only
3- Torsion and reaction forces

e- Rolling bearings has friction :
1- more than sliding bearings
2- less than sliding bearings
3- equal to sliding bearings

f- For the same power transmission, spur gears will have design factor of safety:
1- More than helical gear of same size
2- Equal to helical gear of the same size
3- Less than helical gear of the same size

g- Timing belt has standard size and length:
1- Correct
2- False

h- The surface stress educed in gears depends on:
1- Teeth surface hardness
2- Teeth strength
3- Material creep

i- The effect of buckling must be taken into consideration when the shaft is subjected to:
1- Axial tension load
2- Axial and compression loads
3- Axial compression load

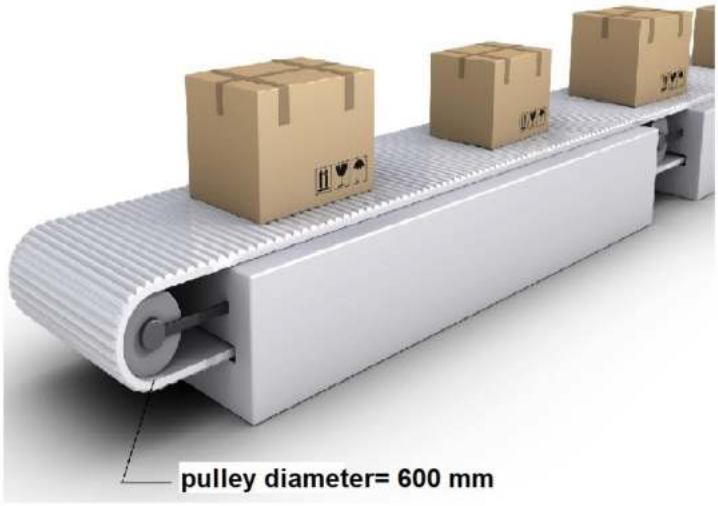
j- In the real wheel drive cars, the real axle is considered as:
   1- Shaft
   2- Not shaft

(B) A simply supported shaft, diameter **50 mm**, on bearing supports carries a radial load of **10 kN** at its center. The axial load on the bearings is **1 kN**. The shaft speed is **1500 RPM**. The bearing static and dynamic capacities are **24 kN** and **28 kN**, respectively. Find the bearing working hours.

Problem (2)

The following figure shows a conveyor belt used to convey boxes of **300 kg** total mass with **15 m/s** linear speed. The belt tensioning force in the tight side of the belts is **900 N** and the friction coefficient between the pulleys and belt is **0.28**. The belt unit length mass is **5 kg/m.**

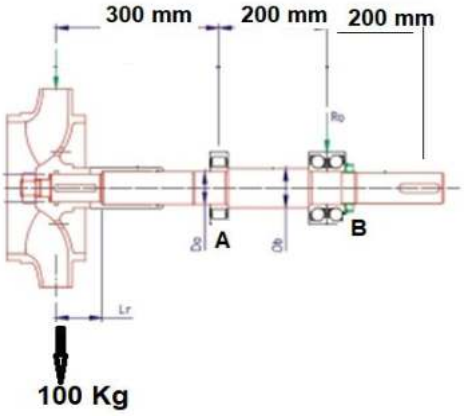
a- Find the belt tensioning forces.
b- Find the length of that belt, if the center distance between the two pulleys is **30 m**.
c- The belt initial tightening force
d- Find the power required to operate this belt conveyor.



Problem (3)

The given figure shows a pump shaft rotating the pump impeller with **750 RPM** and **20 kW** power. The shaft is supported on two bearings **A** and **B**, as shown in figure. By assuming the impeller weight = **100 kg**, determine the following:

a- Shaft diameter (assume allowable shear strength of shaft material = **55 MPa**).
b- Check the shaft rigidity. **G=80 GPa**.



Helpful Data

For Belts and Pulleys

$$\theta_1 = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\theta_2 = 180 + 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$L = \sqrt{4C^2 - (D - d)^2} + \frac{1}{2}(D\ \theta_2 + d\theta_1)$$

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

$$\frac{F_1 - F_c}{F_2 - F_c} = e^{\mu\,\theta}$$

$$F_C = m_e V^2 / R$$

$$F_i = \frac{F_1 + F_2}{2} - F_C$$

Bearing Selection

$$F_e = XVF_r + YF_a$$

$$L = \left[\frac{C}{F_e}\right]^3$$

		$F_a/(VF_r) \le e$		$F_a/(VF_r) > e$	
F_a/C_0	e	X_1	Y_1	X_2	Y_2
0.014*	0.19	1.00	0	0.56	2.30
0.021	0.21	1.00	0	0.56	2.15
0.028	0.22	1.00	0	0.56	1.99
0.042	0.24	1.00	0	0.56	1.85
0.056	0.26	1.00	0	0.56	1.71

ASME Eq. for shaft design

$$d_o = \left[\frac{16}{\pi S_{s\,allow.}(1-\lambda^4)}\sqrt{\left(k_b M_b + \frac{\alpha F d_o (1+\lambda^2)}{8}\right)^2 + (K_t M_t)^2}\right]^{1/3}$$

$$\theta = \frac{TL}{GJ} \quad (\text{rad .})$$