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- same noise as spur gears
3- has high working noise than spur gears

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

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- Equal to helical gear
2- More than helical gear of same size
3- Less than helical gear

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

h- The bending stress educed in gears teeth must be compared to:
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 compression load
2- Axial tension load

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

(B) If SKF bearing with dynamic capacity (**C= 20 kN and C_o= 16 kN**) is used for a pump shaft rotates with **1000 RPM** and under axial load = **0.5 kN** and Radial load = **10 kN**, determine its expected life in working hours.

Problem (2)

The following figure shows a water pump operated by an electric motor through an open type **V-belt** drive. The motor pulley diameter = **100 mm**, pump pulley diameter = **300 mm**, Coefficient of friction for belt with pulleys = **0.32**, Center distance between the two pulleys= **850 mm**; Rotational speed of the motor= **1500 RPM**; Power transmission= **20 kW**; allowable stress for the belt material (S_{all})= **2 MPa**; thickness of the belt= **4 mm**.

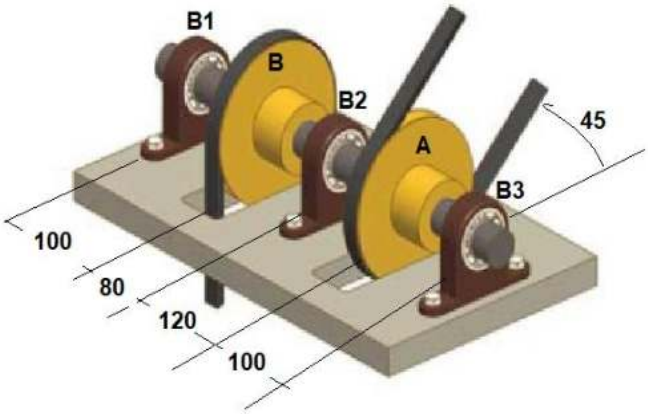
a- Find the belt length
b- Find the belt tensioning forces
c- If the belt permissible tension force is not to exceed **800 N**, how many belts will you need?

Problem (3)

A countershaft carrying two flat-belt pulleys is shown in the following figure. Pulley ***A*** receives a torque of **300 Nm** from a motor through a belt as shown in figure below. The power is transmitted through the shaft and delivered to the belt on pulley ***B***. The belt tensioning forces on pulley ***A*** are **1800** and **270 N** and the belt tensioning forces on pulley **B** are **3000** and **552 N**.

(*a*) Draw the bending-moment diagram for the shaft.

(*b*) Find the safety factor of the shaft (allowable shear strength**= 40 MPa)**



Helpful Data

For Belts and Pulleys

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

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

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

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

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

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

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

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