



Midterm Exam

Name: _____

Student #: _____

Part I – Closed Book

Please Read Questions Carefully – Good Luck!

(20 points)

1. For the flowing statements circle the correct answer.

Two identical bearings are used under the same conditions (same load and rotational speed) but for one of them the inner ring is rotating and for the other the outer ring is rotating. The bearing with a rotating inner ring will live longer than the bearing with rotating outer ring.

T F

The static load rating of ball bearings C_o is always lower than their dynamic load rating C_{10} .

T F

In journal bearings, lubricant side leakage increases with increasing bearing length.

T F

The frictional power loss in journal bearings increases as the *SAE* grade number of the lubricant is increased.

T F

In journal bearings, a steady state condition is reached when the heat generation is less than the heat loss.

T F

For a journal bearing operating under steady (hydrodynamic) lubrication condition, the wear rate depends on the applied load.

T F

For a journal bearing supporting a downward vertical load, the minimum film thickness will occur exactly at the bottom of the bearing.

T F

For two mating helical gears, the two gears should have the same hand of helix and the same helix angle in order to be able to mesh.

T F

For gears, in general, a failure due to wear is more preferred than a failure due to bending.

T F

Helical gears are preferred (over spur gears) for transmitting motion between shafts rotating at high speeds.

T F

For the same pitting resistance factor of safety, hardness of the gear needs to be higher than that of the pinion.

T F

Two compression springs are made of the same wire (same diameter & material) and have the same pitch, coil diameter, and total number of coils. One of the two springs has plain ends and the other has squared ends. The two springs are subjected to the same value of compressive force. Which of the following is true?

- a) The spring with plain ends will deflect more.
- b) The spring with closed ends will deflect more.
- c) Both springs will have the same deflection.
- d) The given information is not sufficient.

An extension spring has a pre-tension of 10 N and a spring rate of 5 N/mm . If the spring is subjected to a tensile load of 20 N , the deflection of the spring will be:

- a) 5 mm
- b) 4 mm
- c) 2 mm
- d) 1 mm

For helical wire springs, which of the following does not affect the spring rate?

- a) Wire diameter
- b) Shear yield strength of the wire
- c) Coil diameter
- d) Number of body coils

Which of the following bearing types can not support an axial (thrust) load?

- a) Tapered roller bearings.
- b) Deep-groove ball bearings.
- c) Angular-contact ball bearings.
- d) All the above types can support both radial and thrust loads.

A rolling-contact bearing has a dynamic load rating of 5 KN at one million cycles. If the bearing is subjected to a load of 1 KN , it will live with the same reliability, for:

- a) One million cycles.
- b) Five million cycles.
- c) More than one million cycles.
- d) The given information is not sufficient.

If the *AGMA* factors of safety for a gear set were found to be $(S_F)_G = 3$, $(S_F)_P = 7$, $(S_H)_G = 2$, and $(S_H)_P = 3$, it means that the transmitted horsepower can be

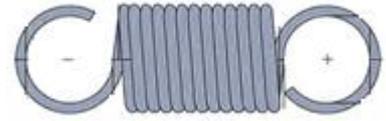
- a) increased 2 times, while we still get the required performance.
- b) increased 3 times, while we still get the required performance.
- c) increased 4 times, while we still get the required performance.
- d) increased 7 times, while we still get the required performance.

Part II – Open Book

Name: _____

(20 points)

2. The extension spring shown is made of gauge-26 music wire. The spring has 15 body turns and its outer diameter is 17.6 mm. The spring is subjected to a static load of 40 N and it has 10 N pre-tension.



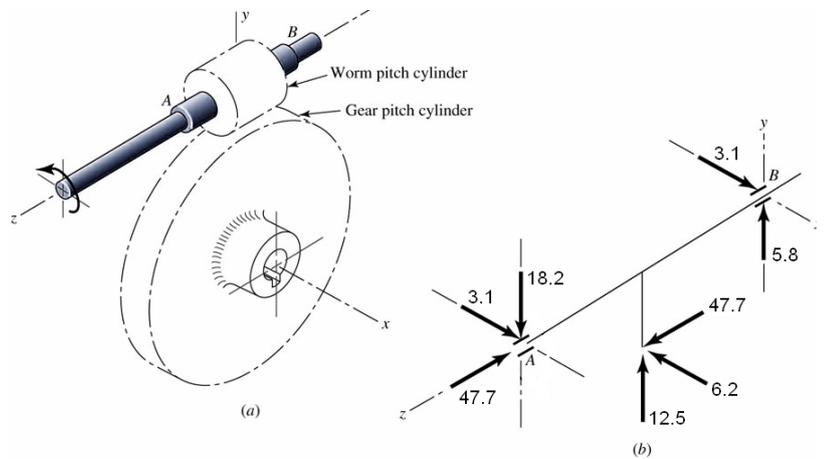
- a) Find the spring rate.
- b) Find the free length and the length when the spring is subjected to the load.
- c) Check if the pre-tension is within the preferred range.
- d) Find the factor of safety for the end-hook in bending.

(20 points)

3. A 95mm – 02 series angular contact ball bearing was selected (From Table 11-2) to be used at location *A* of the shaft shown (knowing that the loads are in *kN*).

Find the expected life of the bearing
(in millions of revolutions) at a
reliability of 0.95.

(The weibull parameters are $x_o = 0.05$,
 $(\theta - x_o) = 4.5$ and $b = 1.5$).



(18 points)

4. An *Oiles SP 800* bushing having 20 mm bore diameter and 30 mm length operates at 50° C in an environment having some foreign matter. The radial load on the bushing is 500 N and the supported shaft rotates at 600 rpm.

- a) Check if the operational condition of the bushing is within the limit for that alloy.
- b) Estimate the reduction in thickness of the bushing after 1000 hours of service (give a conservative estimate).

(22 points)

5. The two stage speed reducer unit shown in the figure consists of three 20° pressure angle spur gears having 10 teeth/in diametral pitch and 1 in face width. The unit transmits 10 hp at an angular speed of 3000 rpm of the pinion. The gear unit is commercially enclosed and the quality standard for the gears is No. 8. The gears are straddle-mounted with bearings immediately adjacent. The unit transmits power from an electric motor (uniform torque) to an air compressor (considered to have moderate shock). All gears are to be made of through-hardened grade-1 steel. The life goal for the gear unit is 6 kh at a combined reliability of 0.97 .

Use $K_T = K_B = 1$

- Find the angular velocity of gear 4.
- What should be the Brinell hardness of gear 4 if the AGMA bending factor of safety for that gear is to be $S_F = 2$

