The Hashemite University
Faculty of Engineering
Mechanical Engineering Department

Machine Design II
Fall 2006
Instructor: Dr. Ala Hijazi

First Exam   *Name:*_____
Part I – Closed Book

Please Read Questions Carefully – Good Luck!

(12 points)
1. For the flowing statements circle one: True or False.

Tapered roller bearings can resist both radial and thrust loads.	T	F
For the same load and operating conditions, the estimated life of a bearing decreases as the required reliability increases.	T	F
A bearing having a dynamic load rating of 5 KN at one million cycles will live, with the same reliability, for five million cycles if the applied load is 1 KN.	T	F
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
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 a journal bearing operating under steady (hydrodynamic) lubrication condition, the wear rate depends on the rotational speed.	T	F
Viscosity of a lubricant increases with increasing SAE number.	T	F
In a journal bearing, the friction keeps decreasing until the bearing reaches its steady state.	T	F
For a driver gear, both faces of each of the teeth will be subjected to an alternating cycles of tension and compression (due to bending).	T	F
For gears, in general, a failure due to bending is more favored than a failure due to wear.	T	F
If the AGMA pitting resistance factor of safety (S_H) for a certain gear was found to be equal to 2, it means that the transmitted load can be increased 4 times, while still get the required performance.	T	F
Spur gears are preferred (over helical gears) for transmitting motion between shafts rotating at high speeds.	T	F

Part II – Open Book   *Name:*_____

(14 points)

2. The figure shows a schematic drawing of a countershaft that supports two V-belt pulleys. For each pulley the tensions are parallel. The shaft runs at 1200 rpm and the bearings (at O and D) are to have a life of 60 kh at a combined reliability of 0.99. The belt tension on the lose side of pulley A is 15% of the tension on the tight side.

a) If you are to select a deep-groove ball bearing from Table 11-2 for use at D, which bearing would you choose? (1 kN = 224.8 lb)

b) Estimate the life (in hours) of the bearing you selected for used at D if the desired reliability for each bearing is 0.9.

c) What is the transmitted horsepower?

(12 points)

3. A full journal bearing has a shaft diameter of 2.000 in with a unilateral tolerance of -0.001 in and a bore diameter of 2.004 in with a unilateral tolerance of +0.001. The bearing length is 2 inches and it is lubricated using SAE 30 lubricant. The journal runs at rotational speed of 2400 rpm and it supports a radial load of 1000 lb. For a minimum clearance assembly and knowing that the <u>average</u> film temperature at steady state conditions is 170º F, find if the bearing satisfies the Trumpler's criterion in terms of:

   a) Minimum film thickness.
   b) Maximum lubricant temperature.
   c) Starting load.

(12 points)
4. A speed reducer unit consists of a 25-tooth 20° pressure angle spur pinion and a 50-tooth gear. The unit transmits 5 hp at an angular speed of 2000 rpm of the pinion. The diametral pitch is 10 teeth/in, the face width is 1 in, and the quality standard for both gears is No. 8. Both gears are through-hardened grade-1 steel where the Brinell hardness of the gear is 250 and that of the pinion is 300. The unit transmits power from an electric motor (uniform torque) to an air compressor (considered to have moderate shock). The desired reliability is 0.999 and the pinion life goal is 10^7 cycles.

Use $K_S = K_m = K_B = 1$ and $Z_N = 2.466 \ N^{-0.056}$

a) Find the AGMA wear resistance factors of safety for the gear and the pinion.
b) If you are required to redesign the speed reducer unit with a design factor of 3, what is the minimum required face width for wear resistance? (Keep every thing the same as in part "a" of the problem).