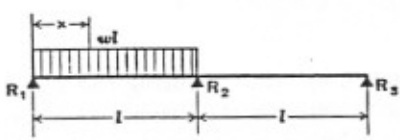
Me413.3 Machine Design I - 2002

19 December 2002

Instructions

This examination is OPEN TEXT BOOK!
Only the text
"Fundamentals of Machine Component Design"
3rd Edition by Juvinal and Marshek may be used.
Calculators are permitted.
Candidates should attempt 5 (FIVE) of the 7 (SEVEN) QUESTIONS
All questions are of equal value.
Formula Sheets are NOT allowed.
TIME allowed is 3 (THREE) hours

1.Find the maximum transverse deflection of the beam shown below. Would



the addition of a torque about the long axis affect that deflection?
Note: that when using singularity functions, a concentrated upward acting transverse force F_o at $x = a$ is denoted as

$$F_o < x - a >^{-1}$$

further the transverse deflection y can be found from the Euler–Bernoulli equation

$$EI\frac{d^4y}{dx^4} = w(x)$$

and that w is the intensity of the transverse load at any point x along the beam.

2. Design a compression coil spring to provide a force change of 800 newtons when the amount of axial compression changes by 0.15m. The actual maximum load will be 750 newtons and should be regarded as static.

3. Design a circular cross section shaft for a fatigue application. The shaft is supported by two bearings that can be considered to provide simple support to the shaft with 90 inches between bearings. The shaft is to carry a constant

torsional load of 37,000 in lb and has a transverse load of 14000 pounds at mid span due to supporting a none rotating mass. Size the shaft for a steel with $S_u = 200,000psi$, $S_y = 125,000psi$, $S_n = 70,000psi$.

Detail design has lead to a 1.35 k_t at the point of maximum bending stress and the k_t in torsion is 2.5.

$$k_f = 1 + (k_t - 1)q$$

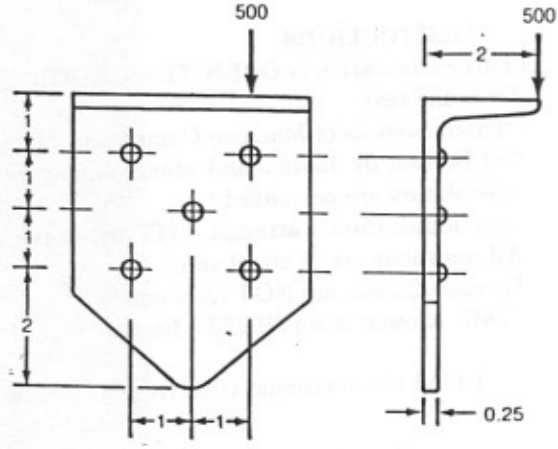
Consider the shaft to be machined and q to be 0.90. Size the shaft assuming for a safety factor N of 4. State any assumptions.

Use the Soderberg relationship for fatigue

$$\frac{\sigma_m}{S_y} + k_f \frac{\sigma_a}{S_n} = \frac{1}{N}$$

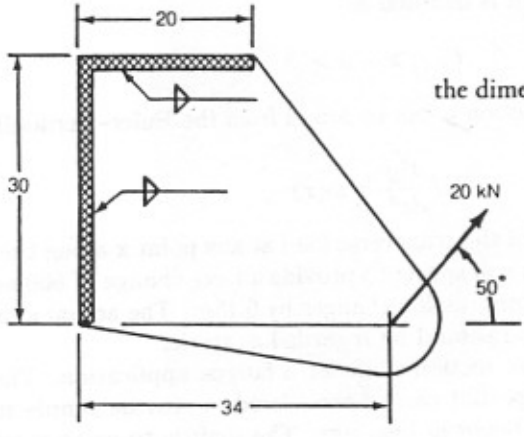
4. Design a V-belt drive to transmit 5hp at 1750 RPM to 10 RPM, assume a safety factor of 1.5. The center distance is 100 inches.

5. The bracket shown below is bolted to a bulkhead as shown. Find the loads carried by each bolt assuming that the bulkhead is rigid.



6. Design a spur gear pair to transmit 4 hp while reducing the speed from 900 rpm to 250 rpm. The center distance between the driving and driven shafts is eight inches. The design should be based on tooth strength only. Do not consider surface damage.

7. Design a weld for the problem illustrated below. The rod used is E70XX •



the dimensions are in mm.

and the tensile yield stress can be taken to be 57ksi.

I hope you have a good Christmas break.