

Me413.3 Machine Design I

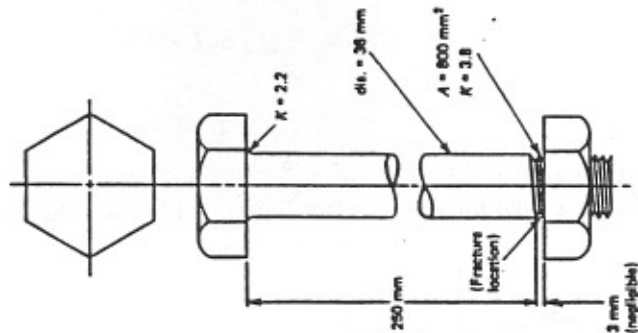
20 December 1999

Instructions

This examination is OPEN BOOK

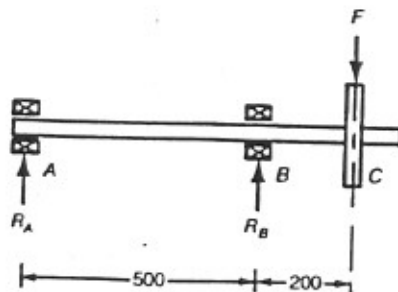
Calculators, textbooks, notes and reference material are allowed.
Candidates should attempt 5 (FIVE) of the 7 (SEVEN) QUESTIONS
TIME allowed 3 (THREE) hours

1. The bolt shown below has 3 areas of stress concentration: the threaded area, the hole drilled through the middle of the shank and a stress concentration where the shank and the head of the bolt meet. How can the bolt be modified to increase it's ability to absorb shock (suddenly applied loads). How much do each of the modifications improve the energy absorption and how great is the total increase in energy absorption? Show each modification diagrammatically.

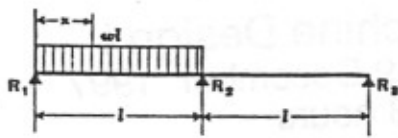


2. Design a coil spring to give a minimum load of 65 lbs and a maximum force of 195 lbs over a 1.2 inch range. Use ASTM A228 wire and assume no preset. The loads on the spring will be repeated enough so that the Wahl factor must be used. The outside diameter of the spring should be less than 2 inches. Give all of the dimensions of this compression spring.

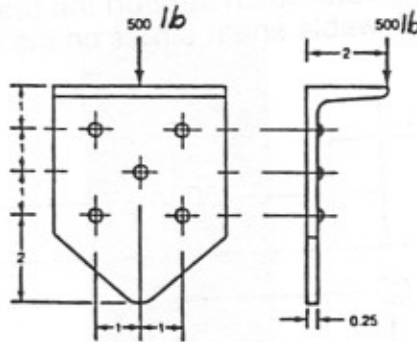
3. A simply supported shaft is shown below. The overhang is subject to a 1500 Newton load as illustrated. In addition the shaft is to carry a constant torsional load of 100Nm. Size the shaft for a steel with $S_u = 750 \text{ MPa}$, $S_y = 430 \text{ MPa}$. Detail design has lead to a $2.5 k_t$ at the point of maximum bending stress and the k_t in torsion is 2.0. Consider the shaft to be machined and q to be 0.90. Size the shaft assuming for a safety factor of 2. State any assumptions.



Dimensions are in millimeters

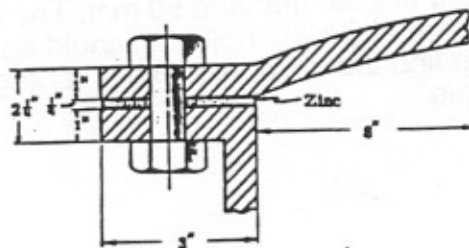


5. The angled bracket shown below is bolted to a wall as shown. Find the loads carried by each bolt. Assuming 6mm diameter SAE Grade III bolts are used, will fatigue be a problem if the load is applied 10 million times. Assume no pre-load in the bolts.



million times. Assume no pre-load in the bolts.

6. A high pressure vessel is shown below. It can be assumed that leakage will not occur unless the compressive load in the joint drops to zero. The lid is held in place by 12 $5/8''$ steel bolts initially tightened to 6000 lb. Will leakage occur?



occur?

7. Analyze the loads carried by the rivets in the joint shown below assuming that friction is not significant and that the load P is 10kN applied at 40 degrees.

