

# WORCESTER POLYTECHNIC INSTITUTE

## MECHANICAL ENGINEERING DEPARTMENT

### Third Extra Credit Problem

GRADE: \_\_\_\_\_

COURSE No.: ME-3320, A'2009  
COURSE NAME: Design of Machine Elements

DATE: 13 October 2009

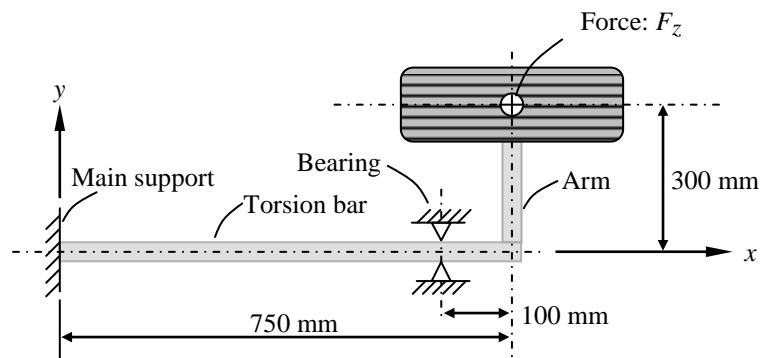
NAME: \_\_\_\_\_  
INSTRUCTOR: C. Furlong  
HL-151  
(508) 831-5126  
cfurlong@wpi.edu  
<http://www.wpi.edu/~cfurlong/me3320.html>

**NOTES:** In all solutions, state explicitly every assumption and/or approximation made, explain every procedure, and justify its use. Dimensional analyses are absolutely necessary. All results must be expressed in appropriate units. PLEASE, ALWAYS SHOW ALL WORK, while writing your results only on one side of the sheet(s) of paper; start each problem on a new sheet. Attach this sheet to your solution.

You can use your book, notes, and assigned homework problems. But cannot consult with neighbor !!

**PROBLEM.** In the rear wheel suspension of the Volkswagen Beetle, the spring motion is provided by a torsion bar fastened to an arm on which the wheel is mounted. See Figure below. According to the Figure, the torque in the torsion bar is created by the force  $F_z$  [-500, 4,500] N acting on the wheel from the ground through a 300 mm lever arm. Because of space limitations, the bearing holding the torsion bar is situated 100 mm from the wheel shaft.

- 1) Determine the diameter of the torsion bar to withstand infinite life with a minimum safety factor of 2. Consider all different types of loading combinations;
- 2) Plot the corresponding modified Goodman's diagram and the possible loading lines.



Assume geometric stress concentration factors of 1.7 and 1.35 for bending and shear, respectively. The torsion bar is to be manufactured with 4340 Ni-Cr-Mo steel quenched and tempered at 1000 °F and having a notch sensitivity factor of 2.0.  
(20 points)

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