



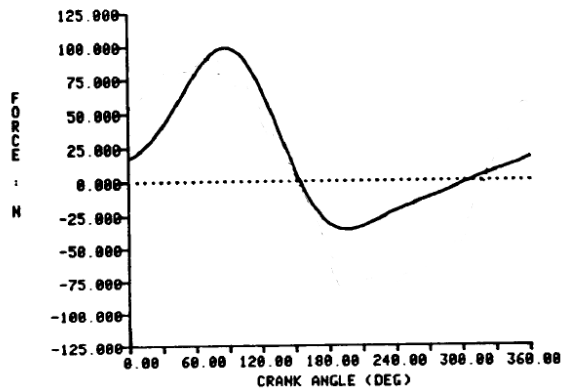
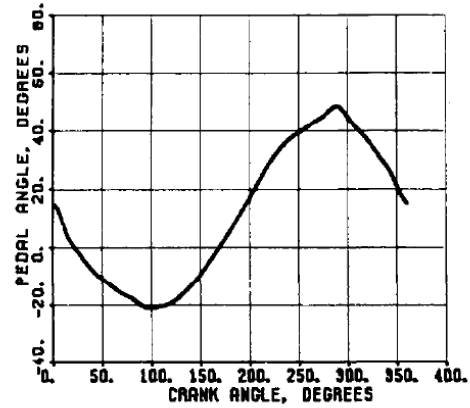
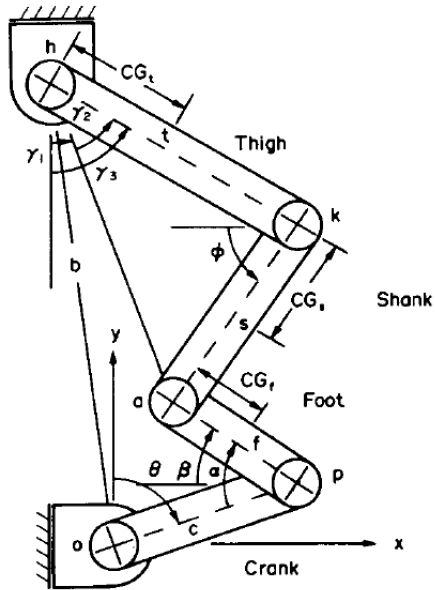
Introduction The figure above shows a fairly simplified representation of a bicycle rider's skeleton. We are interested in studying the stresses generated near all joints, across a crank cycle. A five-bar linkage is proposed in the following page to facilitate the analysis. Two angles need be specified as input to the analysis: crank angle θ and pedal angle β , whose relation to one another is defined in the next page.

Problem #1 Analysis (40 points): Using the model and information above, rank the ankle, knee and hip in terms of the *largest* stress a bicycle rider must endure as he or she slowly pedals along a horizontal path, for a given crank cycle. Measured forces (horizontal and vertical) on the pedal are given in the next page. You will need to specify reasonable dimensions for your model of the rider's leg. Provide appropriate references to your choices. Do not ignore leg mass in this study, but ignore inertial effects (constant-speed pedaling).

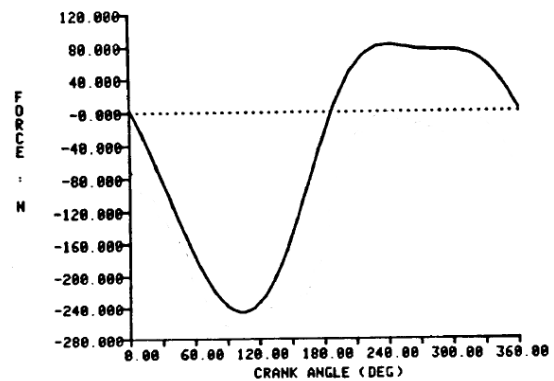
Problem #2 Algorithm (25 points): Plot on MATLAB the largest of the ankle, knee and hip resultant stress, as a function of crank angle. Make sure you submit your code, neat and commented.

Problem #3 Reflection and Adaptation (35 points):

- (a) How well do you think your model approximates the real system? Explain
- (b) How accurate is your coverage and analysis of the crank cycle? Explain
- (c) How did you verify your MATLAB code, to eliminate bugs and to quantify numerical error in your results? Elaborate.
- (d) How do you think your selected model parameters if reasonably changed would change the ranking of the joints in term of stress? Are there standards for these parameters you should consult?
- (e) Is this five-bar linkage model fit for the analysis of joint injury? Explain.
- (f) How would you modify your model to predict stress if the rider is going up an incline? Show an outline of how you would proceed to get your answer.
- (g) Would you expect the ranking of the joints in terms of stress to change if riding up an incline? Explain your answer.



(a) Horizontal pedal force



(b) Vertical pedal force