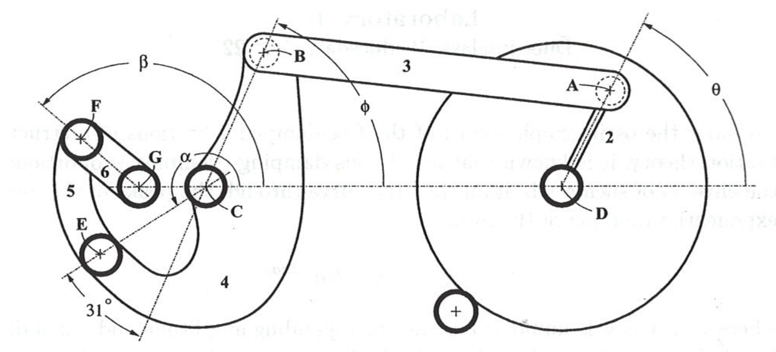
DS 288 (AUG) 3:0 Numerical Methods
Homework–4 [1]

`Due date: November 7, 2024 (Thursday); 10:00 A.M.`

An automatic washer transmission uses the linkage shown in the accompanying figure to convert rotary motion from the drive motor to a large oscillating output of the agitator shaft G. Links 2, 4, and 6 rotate or oscillate about fixed axes. Links 2, 3, and 4 (DA, AB, and BC) along with the fixed base (CD) constitute a four-linkage identical to that from Homework–2, Question-3 where θ_4 (from Homework–2) $= \theta$ (Figure below) $+ \pi$. A second four-bar linkage involving links 4, 5, and 6 (CE, EF, and FG) along with a fixed base (GC) can also be identified as identical to that of Homework–2, Question-3, with $\theta_4 = \alpha$ (Figure below) $+ \pi$. It is of interest to find the angular velocity and the angular acceleration of the agitator shaft for design purposes. Note that for any given θ, the angle ϕ can be found by solving the first four-bar linkage. The angle α is equal to the angle ϕ plus a constant (149^o) and given the angle α, the angle β can be found using the second four-bar linkage problem.



Automatic Washing Machine Drive

DA = 1.94 in	AB = 6.86 in	CB = 2.36 in	EF = 1.87 in
GF = 1.26 in	DC = 7.00 in	CG = 1.25 in	CE = 2.39 in

1. Increment θ from 0^o to 360^o in steps of 1^o and compute ϕ and $d\phi/d\theta$ at each point. Report plot of ϕ and $d\phi/d\theta$ versus θ. For the first derivative, compute both a first forward difference and a centered difference approximation. Plot the two curves on the same graph. How do these two curves compare?. Which do you expect to be more accurate? When using the Newton Algorithm from Homework–2, as you increment θ use the previously found solution as an initial starting guess for the next value of θ. [`4 points`]

2. Now solve the second linkage problem, by determining α from your computed values of ϕ and using Newton's Method on the second linkage system to compute β, $d\beta/dt$ (i.e., the angular velocity in rad/sec), and $d^2\beta/dt^2$ (i.e., the angular acceleration in rad/sec^2). Make plots of these quantities as a function of θ and in case of the derivatives, compute and plot both forward and centered approximations as before. Note that

$$\frac{d\beta}{dt} = \omega\frac{d\beta}{d\theta}; \quad \frac{d^2\beta}{dt^2} = \omega^2\frac{d^2\beta}{d\theta^2} \tag{1}$$

where ω is the rotating speed of the driving gear (in here, assume that $\omega = 450$ rad/minute). As a check on your answers you should find that when $\theta = 100^o$, the angular velocity is near 10 rad/sec and the angular acceleration is close to -25 rad/sec^2. Be careful with units while programming!. [`6 points`]

[1] Posted on: `October 30, 2024`.