MECH 307 Numerical Methods for Mechanical Engineering
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Design Project #2

FORMAT of the file to be submitted:

1. **All the m-files should be named as pr1.m, pr2.m and so on.**
2. **The results (figure, table, or individual result such as x = 2.653, …, and any comment) should be placed in a WORD file named as yourlastname_DP_02.doc**
3. **All the m-files should be inserted at the end of the WORD file using COURIER 9 font.**
4. **The WORD file and all the m-files should ZIPPED together, and the file should be named as yourlastname_DP_01.zip or (or alternatively as yourlastname_DP_02.rar).**
5. **Place the file to the following folder: F:\COURSES\UGRADS\MECH\MECH307\HOMEWORK\...**
6. **During the presentation, you will be asked to enter particular values for the parameters of the problem; and then run your code and present your results in terms of figures, tables, etc. Thus, when you go to the TAs office/lab, please have your laptop turned on, and make your Matlab code(s) ready to be run.**

Problem 1.

The crank AB has a length of r in [m], and it is rotating at a constant angular speed of $d\theta/dt$.

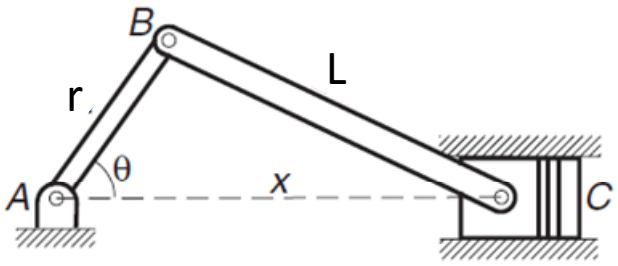
The crank is connected to a connecting rod which has a length of L.

The position, x of the piston C varies with the angle θ as the piston slides in a cylinder.

1. Document the following variables (for one cycle of the rotation of the crank) using appropriately labeled figures:
   (a) Position of the piston, x versus time, t
   (b) Velocity of the piston, dx/dt versus time, t
   (c) Acceleration of the piston, d^2x/dt^2 versus time, t
   (d) Force applied on the piston, $m_{piston}\ d^2x/dt^2$ versus time, t
   (e) Power applied on the piston, $|(m_{piston}\ d^2x/dt^2)\ (dx/dt)|$ versus time, t

   using the following parameters: r = 0.085 m; L = 0.210 m; $d\theta/dt$ = 2000 rpm, m_{piston} = 0.240 kg. Carefully label the axes, and use appropriate dimensions.

2. Animate the motion of the assembly (crank, connecting rod and cylinder); print the values of velocity, acceleration, force and time, as the title of the animation figure.



Note: In Matlab, the argument of sin( ) and cos( ) has to be in radian, not in degrees.

Problem 2.

The radar stations A and B are separated by the distance ***a*** in [m]; and they track the plane C by recording the angles α and β at one-second intervals. The readings are given in the data file, "pr2.dat":

Time [s]	α [°]	β [°]
0	90.0000	109.6538
1.0000	76.9466	96.9355
2.0000	65.2738	84.1164
. . . .	. . . .	. . . .
19.0000	15.6553	17.1901
20.0000	16.4919	18.0248

1. Document the following variables using appropriately labeled figures:

   (a) Position of the plane, x versus y,

   (b) Velocity of the plane, $[(dx/dt)^2 + (dy/dt)^2]^{1/2}$ versus time, t

   (c) Acceleration of the plane, $[(d^2x/dt^2)^2 + (d^2y/dt^2)^2]^{1/2}$ versus time, t

   (d) Climb angle γ (in [°]) versus time, t.

Take a = 500 m.

2. Animate the motion of the plane (by carefully drawing its position and climb angle); print the values of velocity, acceleration, climb angle and time, as the title of the animation figure.

Note that the coordinates of the plane can be written in terms of the two angles as follows:

$$x = a\frac{\tan\beta}{\tan\beta - \tan\alpha} \qquad y = a\frac{\tan\alpha\tan\beta}{\tan\beta - \tan\alpha}$$