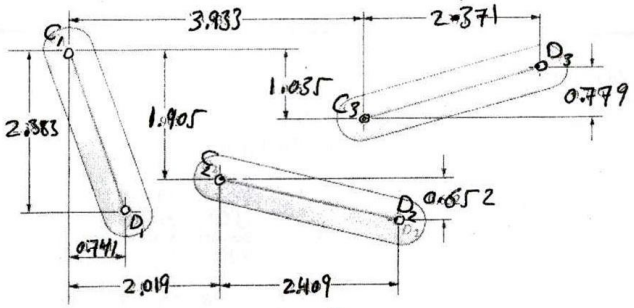
# Final Exam (2nd Year Industrial)
## Theory of Machines

Date: 27/01/2016 Time: 09:30 am – 12:30 pm
Total grade: 60 points

***Notes***: *1. Answer all questions*
*2. Allowable aids are calculator, drawing tools, and included data sheet*

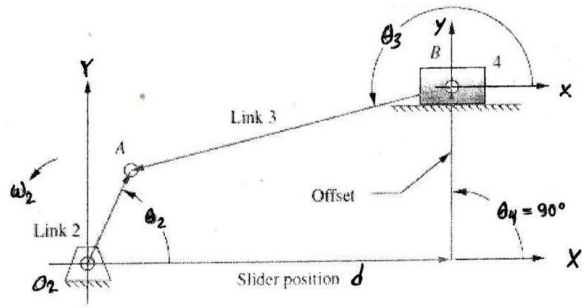
**Question No. (1); (10 points)**

The figure shows three positions of coupler motion. Dimensions are in inch. Design a four bar linkage using graphical method, and check Grashof condition. Add a driver dyad, and write the length of all the six links.



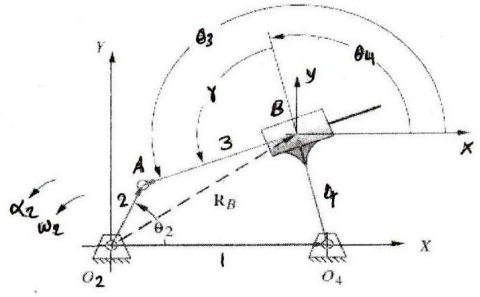

**Question No. (2); (10 points)**

The general linkage configuration and terminology for an offset fourbar slider-crank linkage are shown in the figure. The link lengths are link2=1.4 in, link3=4 in, and the offset=1 in. The values of $\theta_2$ and $\omega_2$ are 45° and 10 rad/sec respectively. Knowing that $\theta_3$=180°, find graphically and anlytically the velocities of the pin joints A and B and the velocity of slip at the sliding joint, and comment the results.



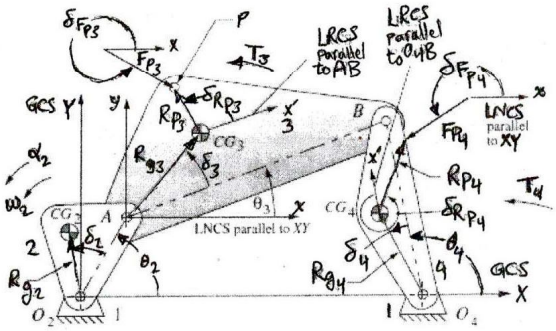
**Question No. (3); (10 points)**

The figure shows an inverted fourbar slider-crank linkage. Derive analytically the accelerations at points A and B using vector loop positions method. Knowing that $\theta_3$=232.667°, $\omega_3$=-10.292 rad/sec, and sliding velocity=33.461 in/sec, find the coriolis acceleration at point B.




**Question No. (4); (10 points)**

The figure shows a pin-jointed fourbar linkage. It has $\theta_1 = 0$. Write the equations of the unknown forces and torques in each link (do not write the final matrix).

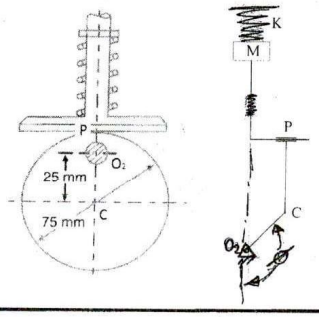



**Question No. (5); (15 points; 5+10)**

The figure shows a circular cam disc, its spring loaded flat follower at its closest position to the cam rotating center $O_2$ (i.e. when $\Phi = 0$) and the equivalent mechanism at general position. You are requested to find:

a- The follower position, velocity and acceleration in terms of the cam rotating angle $\Phi$, the cam constant angular speed of rotation $\omega$ and the offset between circle center C and cam center of rotation $O_2$, where ($O_2C = r$).

the follower mass M= 2.3 kg, the spring stiffness is K= 3.5 N/mm, the initial spring compression generates 45 N and the cam moves in vertical direction (the weight is considered), then find the angular speed at which cam-follower separation starts.



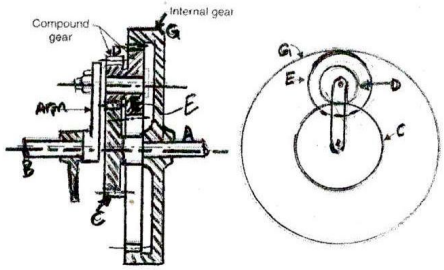

**Question No. (6); (10 points; 5+5)**

(A) Define the following terms, use proper sketches when required:

| | | |
|---|---|---|
| a- Addendum | b- Dedendum | c- Pitch circle |
| d- Base circle | e- Pressure angle | f- Face width |
| g- Tooth thickness | | |

(B) The figure shows a compound planetary gear train. The two shafts A and B are co-axial. Gear C (50 teeth) is rigidly mounted on shaft A. The compound gear D-E gears are mounted on the arm. Gear D has 20 teeth and gear E has 35 teeth. The internal gear G is fixed and is concentric with the shaft axis.

a- If all gears have the same module, find the number of teeth on gear G.
b- If the shaft A rotates CW at 100 rpm, find the speed of shaft B.




*THE END*
*BEST WISHES*