DYNAMICS OF MECHANISMS
MECH-314

MIDTERM EXAM

Wednesday, March 19, 2014, 13:05 – 14:25

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

- STUDENTS ARE ONLY ALLOWED A ONE-PAGE (8.5” X 11”) CRIB-SHEET, WITH WRITING ON BOTH SIDES.
- PLEASE ANSWER ALL QUESTIONS.
- QUESTIONS MUST BE ANSWERED DIRECTLY ON THE EXAM PAPER, IN THE SPACE PROVIDED BELOW OR BESIDE THE QUESTIONS.

Student Name:

Student Number:

Question 1: [5]
What are the first order kinematic coefficients?

Question 2: [5]
Enunciate the Aronhold-Kennedy theorem.

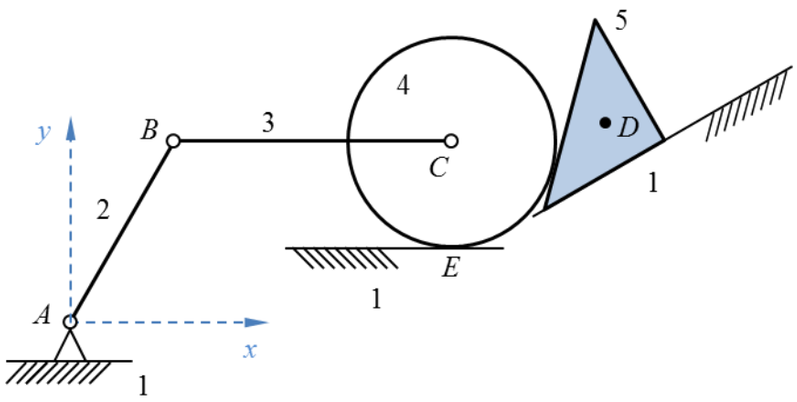
Question 3: [5 (bonus)]
Kinematic pairs represent the geometric or kinematic constraints imposed on the motion of the links of a mechanical system. What is the main difference between higher and lower kinematic pairs?

Problem 1: [25 + 15]

The figure shows the scaled kinematic diagram of a mechanism (scale 1 cm : 1 cm). The following dimensions are known: R_{BA} = 3 cm, R_{CB} = 4 cm, R_{CE} = 1.5 cm. The angular velocity of link 2 is ω_2 = 10 rad/s, ccw. The contacts between link 4 and links 1 and 5 are general direct contacts, where slip is possible. The contact between links 5 and 1 can be considered a prismatic pair.

a) Determine the apparent velocity of point C_4 with respect to link 5 ($V_{C4/5}$), and the velocity of point D_5. Use graphical velocity analysis and scale 1 cm : 5 cm/s. Give the detailed set of necessary velocity difference and/or apparent velocity equations and construct the velocity vector diagram. What is the angular velocity of link 5?

b) Assume rolling at point E between links 1 and 4. For this case, determine the angular velocity of link 4, ω_4.



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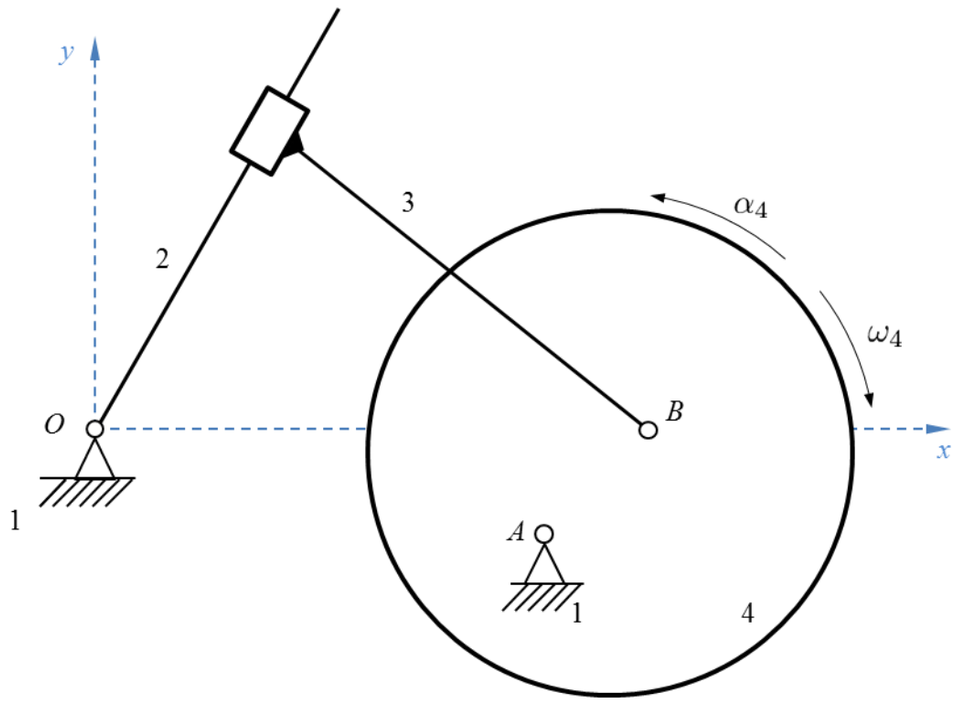
Problem 3: [35 + 15]

The scaled position diagram of a mechanism is shown in the figure: R_{BO} = 8 cm, R_{BA} = 2.1 cm. Disk 4 is attached to link 1 via a revolute joint at point *A*. The angular velocity of link 4 is ω_4 = 1 rad/s cw. From the velocity analysis of the mechanism, it is known that $\omega_3 = \omega_4$ = 0.51 rad/s cw, and the apparent velocity of point B_3 with respect to link 2 ($V_{B3/2}$) is 3 cm/s, parallel to link 2 and pointing upwards. The input of the mechanism is α_4 = 2 rad/s^2, ccw.

a) Perform the complete acceleration analysis of the mechanism using the graphical method. Obtain the acceleration images for points B_2, B_3, and B_4. Give the necessary sets of acceleration difference and/or apparent acceleration equations. Use scale 1 cm : 1 cm/s^2.

b) Determine the angular acceleration of link 2 (α_2) and the acceleration of point B_2.



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