南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

2018
Fall Semester
Final Exam Paper

Course Name: MAE 203B **Dept.:** MAE **Exam Duration:** 2 hours

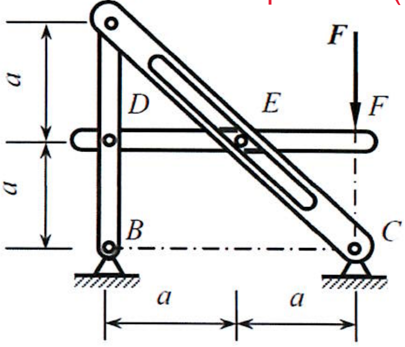
Question No.	1	2	3	4	5	6		Total
Score	20	15	15	10	20	20		100

This exam paper contains **6** questions and the score is **100** in total. (Please hand in your exam paper, answer sheet, and your scrap paper to the proctor when the exam ends.) You may answer the questions in English or in Chinese, but please write your answers *clearly*.

Formulas for moments of inertia (about the centroids):

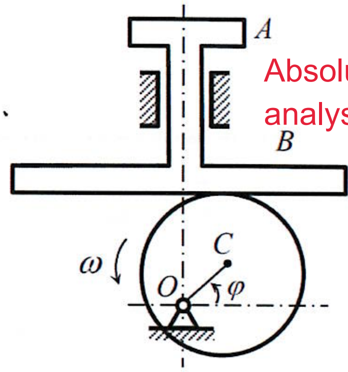
a uniform circular disk $I = \frac{1}{2}mr^2$, a uniform rod $I = \frac{1}{12}mL^2$

Frame problem (statics)

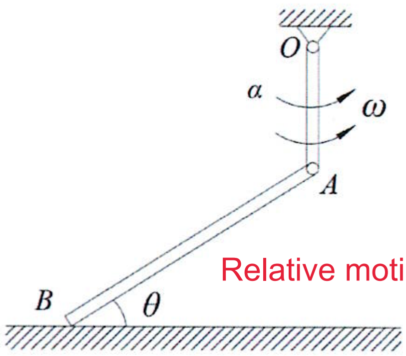


1. (20 pts) The frame shown consists of three rigid bars, AB, AC, and DF. The bars are connected through frictionless joints at A, B, C, and D. Pin E over bar DF can slide freely in the slot on bar AC. Neglect the weights of all members. Calculate the forces exerted by pins A, B, and D to the vertical bar AB. Express your results in terms of the vertical load F.

Absolute motion analysis



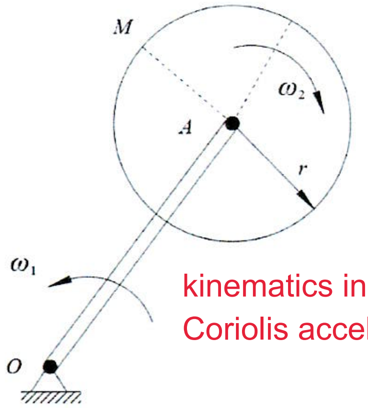
2. (15 pts) A circular wheel is rotating about point O at a constant angular velocity ω. The eccentric distance $OC = e$, and the radius of the wheel is R. Part AB is mounted in a fit slot and is only moving in the vertical direction along the axis going through point O. The bottom surface of part AB is smooth and is kept horizontal, and it is always in contact with the wheel. Calculate the velocity and acceleration of part AB at the instant when $\varphi = 30°$.



Relative motion analysis

3. (15 pts) The mechanism shown consists of two rigid bars moving in-plane. Bar OA, with a length of $r = 10\text{cm}$, is rotating about pin O. Bar AB has a length of $l = 20\text{cm}$, and point B only moves horizontally on the surface. At the instant when OA is vertical and $\theta = 30°$, the angular velocity and angular acceleration of OA are $\omega = 1\ \text{rad/s}$ and $\alpha = 10\ \text{rad/s}^2$, respectively (both counterclockwise). Calculate the velocity and acceleration of point B and the angular velocity of AB at this instant.

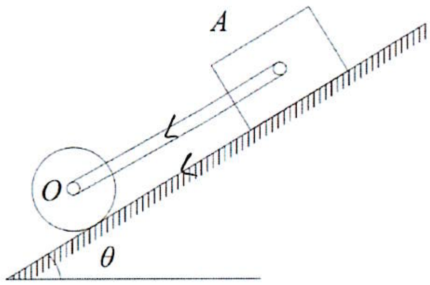
4. (10 pts) A disk of radius $r = 5\mathrm{cm}$ is connected to shaft OA of length $2r$ at its center. The shaft OA rotates about the fixed point O with a constant angular velocity $\omega_1 = 5\ \mathrm{rad/s}$ and the disk rotates about point A with a constant angular velocity $\omega_2 = 2\ \mathrm{rad/s}$, relative to bar OA. Take OA as the reference frame, calculate the Coriolis acceleration of point M, and indicate the direction of it on the diagram.



kinematics in a rotating frame
Coriolis acceleration

rod.
1. no mass

5. (20pts) The system shown on the figure consists of a uniform circular wheel O and a rectangular block A, connected through a rigid link with frictionless pins. The disk and the block together move down a slope of angle θ. The disk has mass m and radius r, and is rolling without slipping. The mass of the block is also m, and the kinetic friction coefficient between the block and the slope is μ. Find: 1) the acceleration of point O; and 2) the internal force in the link.



6. (20 pts) A uniform and rigid bar AB of length l connects a socket A and a uniform disk B, both through frictionless pins. The mechanism is released from a stationary state as shown, after which the socket slides downwards over the frictionless vertical guide rail, and the disk rotates without slipping. Bar AB has mass m_1 while disk B has mass m_2. The massless spring has a spring constant k and is relaxed when in contact with AB in its horizontal state (as shown by the dash lines). Find

a) the angular velocity of bar AB, ω_{AB}, and that of the disk ω_B, when AB is horizontal;

b) the acceleration of point B (center of the disk) and its direction when AB is horizontal;

c) the maximum compression δ of the spring.