TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
B Tech. Mechanical Engineering
TMC 4212 : MECHANICS OF MACHINES I
SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: SEPTEMBER 2018
TIME: 2 HOURS
DATE: Pick Date **Sep 2018**

Instruction to Candidates:
You should have the following for this examination
- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt question **ONE** and any other **TWO** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.

Question ONE

a) Give the classification of kinematic pairs according to the following considerations:
   i) According to the type of relative motion between the elements (5 marks)
   ii) According to the type of contact between the elements. (2 marks)
   iii) According to the type of closure (2 marks)

b) With the aid of suitable diagrams and using the expressions $l = 2p - 4$ and $j = 1.5l - 2$, describe the following types of kinematic chains:
   i) Locked chain
   ii) Constrained kinematic chain
   iii) Unconstrained chain

(6 marks)

c) In the slider crank mechanism shown in figure 1, the crank OA rotates at 30 rpm and transmits motion to the sliders B and D. if the dimensions for the various links are given as AB = 1000 mm, OA = 200 mm and BC = CD = 400 mm, find:

i) Velocities of sliding at B and D,
ii) Angular velocity of CD,
iii) Linear acceleration of D, and
iv) Angular acceleration of CD.

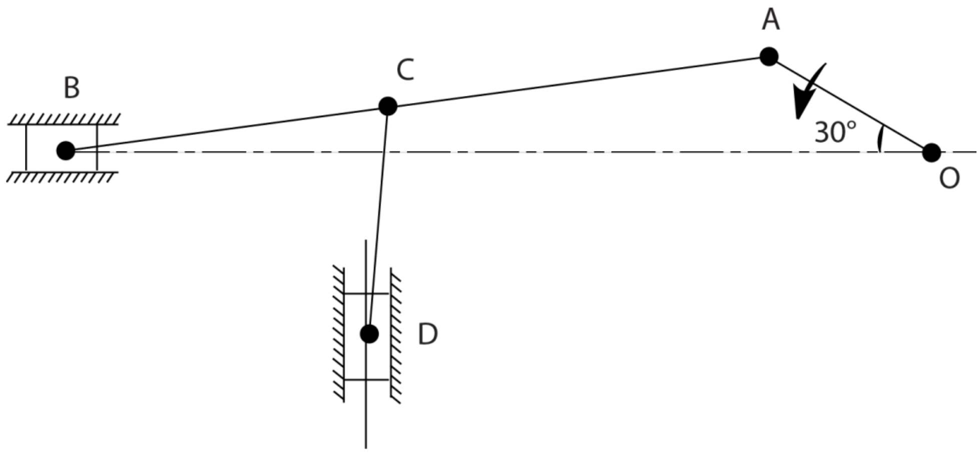


Fig. 1

(15 marks)

Question TWO

a) Locate all the instantaneous centres for the crossed four bar mechanism as shown in Figure 2. The dimensions of various links are: CD = 65 mm; CA = 60 mm; DB = 80 mm; and AB = 55 mm. Find the angular velocities of the links AB and DB, if the crank CA rotates at 100 rpm in the anticlockwise direction.

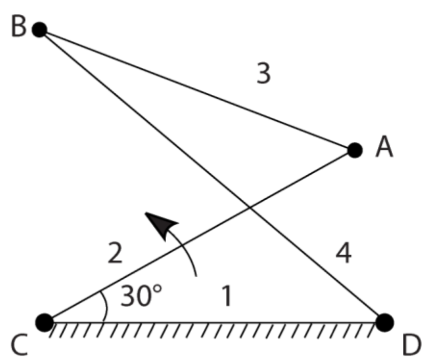
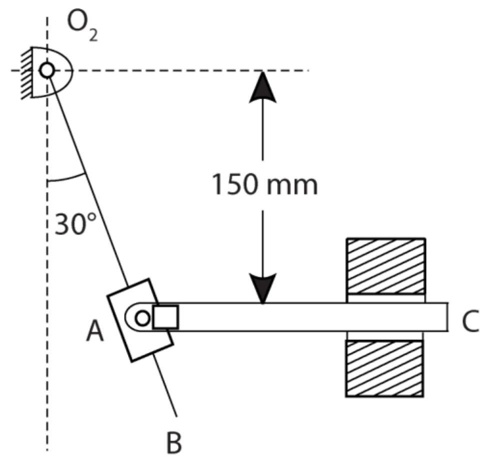


Figure 2

(10 marks)

b) The mechanism as shown in Figure 3 is a marine steering gear, called Rapson's slide. O_2B is the tiller and AC is the actuating rod. The velocity of AC is 25 mm/min to the left. Find, using the relative velocity method, the angular velocity of the tiller.



(10 marks)

Question THREE

A mechanism of a crank and slotted lever quick return motion is shown in Figure 3. If the crank rotates counter clockwise at 250 rpm, determine for the configuration shown, the velocity and acceleration of the ram D. Also determine the angular acceleration of the slotted lever. Crank, AB = 200 mm; Slotted arm, OC = 900 mm and link CD = 300 mm.

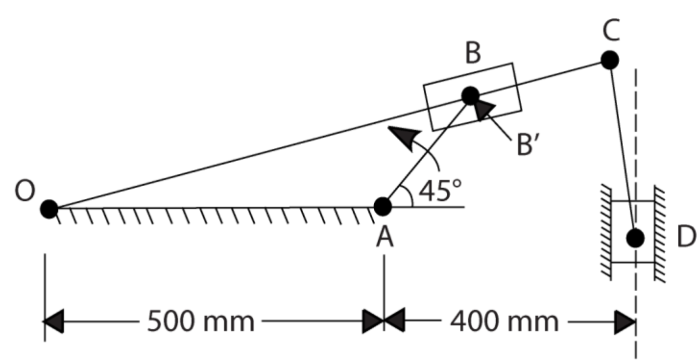


Figure 3

(20 marks)

Question FOUR

a) With the aid of suitable diagrams describe how balancing of several masses rotating in the same plane is carried out using:
   i) The analytical method

ii) The graphical method

(10 marks)

b) A single cylinder engine runs at 250 rpm and has a stroke of 180 mm. The reciprocating parts have a mass of 120 kg and the revolving parts are equivalent to a mass of 70 kg at a radius of 90 mm. A mass is placed opposite to the crank at a radius of 150 mm to balance the whole of the revolving mass and two-thirds of the reciprocating mass. Determine the magnitude of the balancing mass and the resultant residual unbalance force when the crank has turned 30° from the inner dead centre, neglect the obliquity of the connecting rod.

(10 marks)

Question FIVE

a) An aeroplane runs at 600 km/h. The rotor of the engine weighs 4000 N with radius of gyration of 1 metre. The speed of rotor is 3000 rpm in anticlockwise direction when seen from rear side of the aeroplane. If the plane takes a loop upwards in a curve of 100 metres radius, find :

i) The gyroscopic couple developed; and
ii) The effect of reaction gyroscopic couple developed on the body of aeroplane.

(6 marks)

b) A racing car weighs 20 kN. It has a wheel base of 2 m, track width 1 m and the height of its centre of gravity is 300 mm above the ground level and lies midway between the front and rear axle. The engine flywheel rotates at 3000 rpm clockwise when viewed from the front. The moment of inertia of the flywheel is 4 kg-m^2 and moment of inertia of each wheel is 3 kg-m^2. Find the reactions between the wheels and the ground when the car takes a curve of 15 m radius towards right at 30 km/h, taking into consideration the gyroscopic and the centrifugal effects. Each wheel radius is 400 mm.

(14 marks)