



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: November 2017

Module Number: ME 4304

Module Name: Mechanics of Machines

[Three Hours]

[Answer all questions, each question carries twelve marks]

Draw neat sketches to justify your answers, where necessary.

- Q1. a) Kinematic pairs can be classified according to the type of relative motion between the elements such as; Prismatic Pair, Revolute Pair, Rolling pair, Screw Pair and Spherical Pair. Give at least one example for each of them. [2.5 Marks]
- b) Explain briefly with neat sketches how to obtain each of following from the single slider crank chain.
- Pendulum Pump
 - Oscillating Cylinder Engine
 - Rotary Internal Combustion Engine
 - Crank and Slotted Lever Quick Return Motion Mechanism
 - Whitworth Quick Return Motion Mechanism
- [5.0 Marks]
- c) Give at least three mechanisms that can be obtained from the inversions of double slider crank mechanism. [1.5 Marks]
- d) The Figure Q1 shows a five link chain. Explain why it has little practical importance in kinematics. [3.0 Marks]
- Q2. a) Clearly state the Kennedy's theorem and give a definition for the Instantaneous Centre. [1.0 Marks]
- b) A quick return mechanism of the crank and slotted lever type shaping machine is shown in Figure Q2. The dimensions of the various links are as follows,
- $O_1O_2 = 800 \text{ mm}$; $O_1B = 300 \text{ mm}$; $O_2D = 1300 \text{ mm}$; $DR = 400 \text{ mm}$.
- The crank O_1B makes an angle of 45° with the vertical and rotates at 50 rpm in the counterclockwise direction.
- Draw the space diagram and the velocity diagram for the mechanism. [2.0 Marks]
 - Calculate the velocity of the ram (R) or the velocity of the cutting tool by using relative velocity method. [2.0 Marks]
 - Calculate the angular velocity of link O_2D . [2.0 Marks]

- c) i. What is the function of a governor? [1.0 Marks]
- ii. What is meant by equilibrium speed of a governor? [1.0 Marks]
- iii. List-out three practical applications of governors and briefly explain how the governors would aid the maneuvering the operation of the applications you indicated. [3.0 Marks]
- Q3. a) Explain the terms "static balancing" and "dynamic balancing" by giving necessary conditions to achieve them. [3.0 Marks]
- b) "Unbalanced rotating systems reduce machine life". Provide justification to prove the statement. [3.0 Marks]
- c) Describe four possible methods to balance the unbalanced systems. [2.0 Marks]
- d) The camshaft of a high speed pump consists of a parallel shaft of 25 mm diameter and 480 mm long. It carries three eccentrics, each of 60 mm diameter and a uniform thickness of 18 mm. The assembly is shown in Figure Q3 (d) and the bearings are at A and B. The angle between the eccentrics is 120° and the eccentricity of each is 12.5 mm. The material density is 7000 kg/m^3 , and the speed of rotation is 1430 rpm. Find;
- i. Dynamic load on each bearing. [2.0 Marks]
- ii. Kinetic energy of the complete assembly. [2.0 Marks]
- Q4. a) Classify the cam mechanism according to the motion of follower. [2.0 Marks]
- b) Discuss the importance of cam mechanism in industrial applications giving at least two examples. [2.0 Marks]
- c) Provide a suitable sketch to represent following cam nomenclature.
- i. Base circle.
- ii. Pitch point.
- iii. Prime circle.
- iv. Stroke. [2.0 Marks]
- d) List four types of follower motions. [2.0 Marks]
- e) Construct the profile of a cam to outfit the following specifications;
 Cam shaft diameter = 40 mm; Least radius of the cam = 25 mm; Diameter of the roller = 25 mm; Angle of lift = 120° ; Angle of fall = 150° ; Lift of the follower = 40 mm; Number of pauses are *two* of equal intervals between motions. During the lift, the motion is simple harmonic. During the fall, the motion is uniform acceleration and deceleration. The speed of the cam shaft is uniform. The line of stroke of the follower is off-set to 12.5 mm from the centre of the cam. [4.0 Marks]

- Q5. a) i. Briefly explain the Conjugate gear-tooth action. [2.0 Marks]
- ii. Discuss the effect of pressure angle, when transmitting the power from one shaft to another in gearing mechanisms. [2.0 Marks]
- iii. What is Backlash in gears and briefly discuss a method to avoid it. [2.0 Marks]
- iv. State four advantages and disadvantages of gear trains compared to belt, rope and chain drivers. [2.0 Marks]
- b) Determine the minimum number of teeth required on a pinion, in order to avoid interference which is to gear with,
- i. A wheel to give a gear ratio of 3:1 [2.0 Marks]
- ii. An equal wheel. (The pressure angle is 20° and a standard addendum of 1 module for the wheel may be assumed) [2.0 Marks]

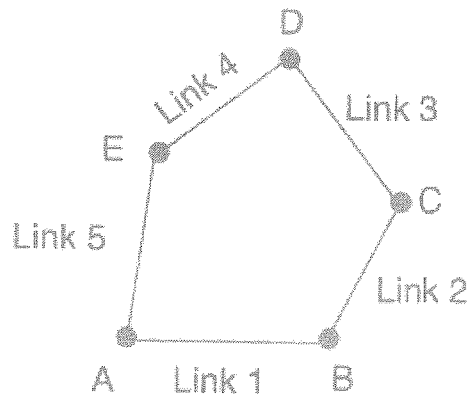


Figure Q1

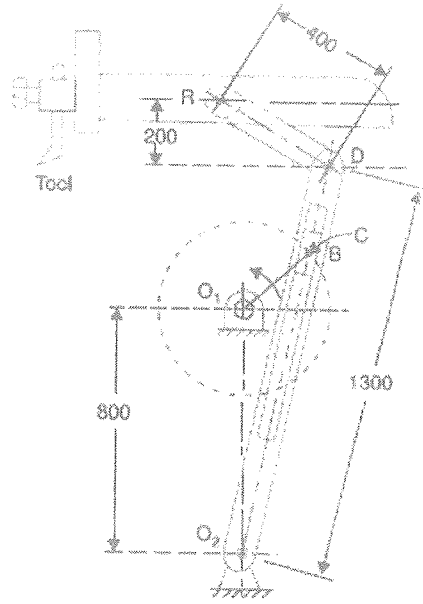
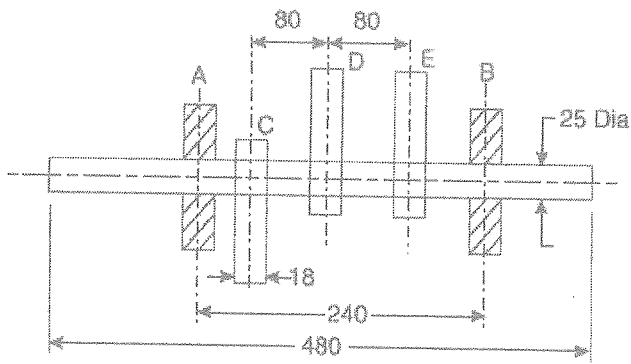


Figure Q2



All dimensions in mm.

Figure Q3(d)

