



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: December 2015

Module Number: ME4304

Module Name: Mechanics of Machines

[Three Hours]

[Answer all questions, each question carries ten marks]

You may make additional assumptions where necessary, but clearly state them in your answers. You must draw neat sketches to justify your answers

- Q1 a) i) Briefly explain the meaning of Degree of Freedom (DOF) of a mechanism and how you can predict assembly characteristics of a mechanism by using its DOF. [2.0 Marks]
- ii) Figure Q1 shows a of cam mechanism. Find its DOF and suggest an application for it. [2.0 Marks]
- iii) Briefly discuss kinematic chains in mechanisms providing two examples. [2.0 Marks]
- b) i) State Grashof condition for four bar linkage in planar mechanism. [2.0 Marks]
- ii) Briefly explain the four bar linkage mechanism. [2.0 Marks]
- Q2 a) Clearly states the Kennedy's theorem and give a definition for the instantaneous centre. [2.0 Marks]
- b) The crank of a slider crank mechanism shown in Figure Q2 is 15 cm long and the connecting rod is 60 cm long. The crank rotates 300 rpm in the clockwise direction and a constant driving torque of 50 Nm is applied, when it has turned 45° from the inner dead centre position.
- i) Locate all instantaneous centres on a space diagram. [2.0 Marks]
- ii) Calculate the velocity of the slider by using relative velocity method. [2.0 Marks]
- iii) Calculate the acceleration of the midpoint of the connecting rod. [2.0 Marks]
- iv) Find the resisting torque if the efficiency of the mechanism is 85%. [2.0 Marks]

- Q3 a) i) What are the characteristics of unbalanced rotating systems? [2.0 Marks]
- ii) What are the manufacturing causes which may result in unbalanced rotating systems? [2.0 Marks]
- iii) It is often economically unfeasible to balance rotors and fitments after they have been assembled. Briefly explain the reasons for that. [2.0 Marks]
- b) A, B, C and D are four masses carried by a rotating shaft at radius 100 mm, 125 mm, 200 mm and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the masses of B, C and D are 10 kg, 5 kg, and 4 kg respectively. Find the mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. [4.0 Marks]
- Q4 a) Classify the types of cams and followers. [3.0 Marks]
- b) Briefly explain the following terms.
- i) Joint closures of cams
 - ii) Base circle
 - iii) Pressure angle
 - iv) Stroke
 - v) Pitch point
 - vi) Dwell
- [3.0 Marks]
- c) A gloves manufacture requires to set out a profile of a cam having an oscillating follower as described below.
- Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion.
 - Dwell for the next 30° .
 - During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion.
 - Dwell during the remaining 180° .
- Draw the profile of the cam when the line of stroke is offset by 20 mm from the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 rpm. [4.0 Marks]

- Q5 a) i) Briefly explain the conjugate gear-tooth action. [1.0 Mark]
- ii) Discuss the effect of pressure angle, when transmitting the power from one shaft to another in gear mechanisms. [1.0 Mark]
- iii) What is meant by backlash in gears? Briefly discuss a method to avoid it. [1.0 Mark]
- iv) Discuss the nomenclature of spur gears. [2.0 Marks]
- b) Figure Q5 shows a gear box that has been used for a conveyer system having two co-axial shafts A and B. Gear C (50 teeth) is rigidly mounted on shaft A. A compound gear D-E gears with C and the internal gear G. Gear D (20 teeth) gears with Gear C. Gear E (35 teeth) gears with the internal gear G. The gear G is fixed and it is concentric with the shaft axis. The compound gear D-E is mounted on a pin which projects from an arm, keyed to the shaft B. Find the number of teeth on internal gear G assuming that all the gears have the same module. If the shaft A rotates at 110 rpm find the speed of shaft B. [5.0 Marks]
- Q6 a) Briefly discuss four mechanisms that can be used to design a machine. [2.0 Marks]
- b) A footwear manufacture is going to introduce a new system to produce rubber slippers. You are asked to develop a punching mechanism system to produce slippers continuously by using your knowledge in Mechanics of Machines. Suppose that the manufacturer is using 1cm thick and 20 cm wide rubber sheet rolls for the manufacturing process. You may use a 5kW electric motor to power the system. Propose a suitable punching mechanism. Clearly name type(s) of mechanism(s) that you have used and provide necessary drawing(s)/sketch(s) to describe the system. [8.0 Marks]

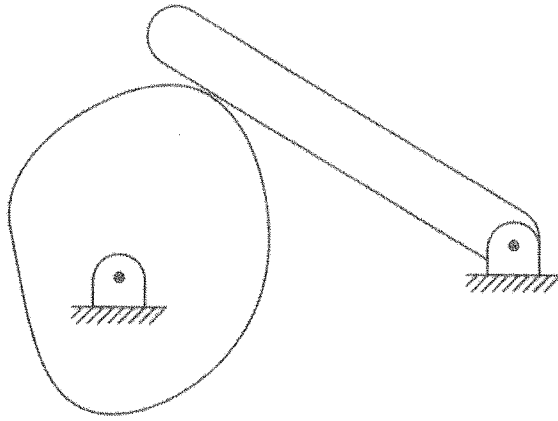


Figure Q.1

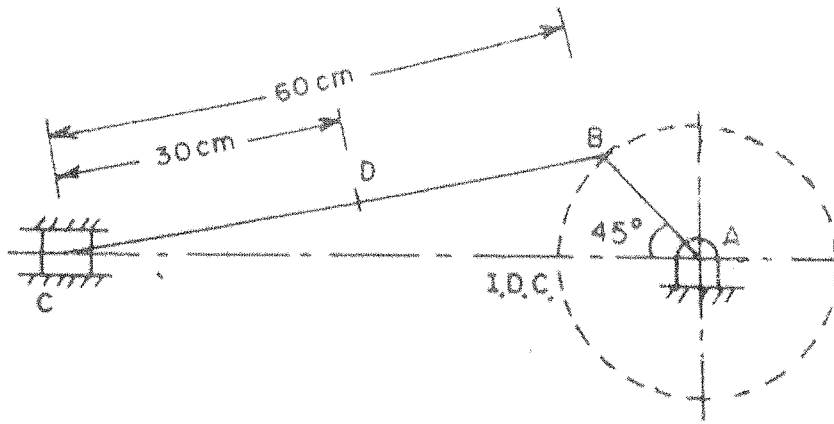


Figure Q.2

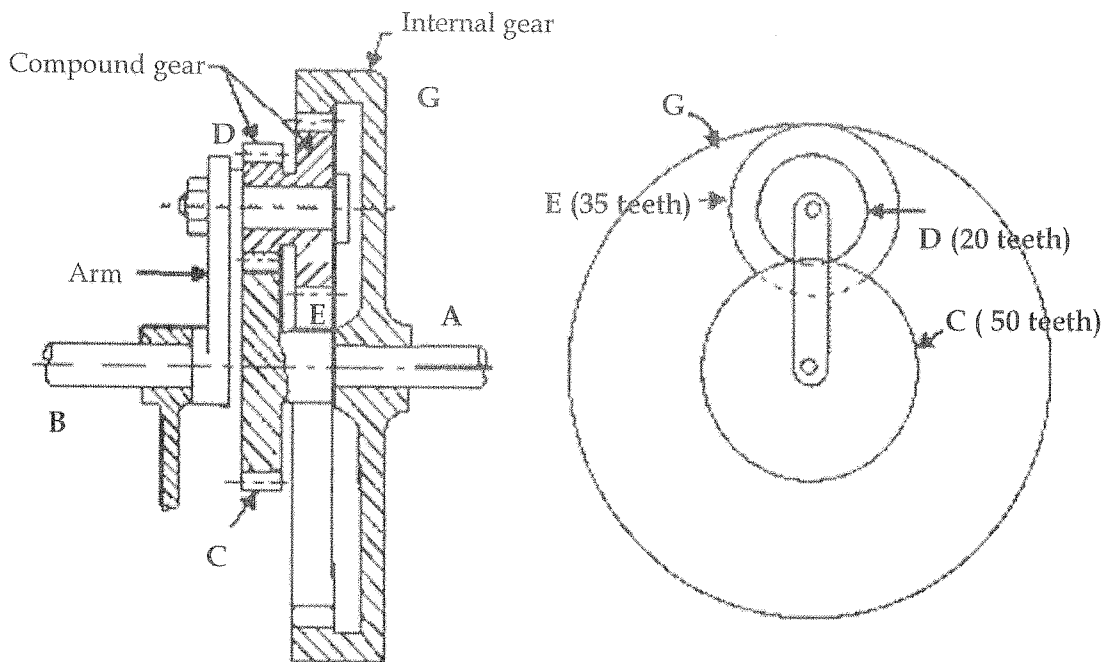


Figure Q.5