UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: December 2016

Module Number: ME4304 **Module Name: Mechanics of Machines**

[Three Hours]

[Answer **all questions**; each question carries **twelve marks**; provide neat sketches where necessary; make reasonable assumptions and state them clearly]

Q1 a) List out four engineering mechanisms with a suitable example for each.

[2.0 Marks]

b) Briefly discuss what is meant by 'machine' with the help of mechanism?

[1.0 Mark]

c) What is the difference between kinematics and kinetics?

[1.0 Mark]

d) Explain motion generation mechanism by using a suitable example.

[2.0 Marks]

e) Small scale soap manufacturer needs a machine to cut bar soap into small pieces and punch company logo on the soap at the same time. You are asked to develop a manual operated machine to fulfill following tasks.

- To feed soap bar in to the cutter.
- To cut soap pieces and punch company logo on the soap piece.

Provide properly named sketches of your design.

[6.0 Marks]

Q2 a) Figure Q2 shows a cam mechanism. Classify it according to the shape, path and motion of the follower.

[2.0 Marks]

b) Find Degrees of Freedom (DOF) of the cam mechanism in Figure Q2.

[2.0 Marks]

c) Briefly discuss following terms in standard cam nomenclature,

i) Base circle,
ii) Stroke,
iii) Trace point,
iv) Prime circle.

[2.0 Marks]

d) Small scale bottled fruit juice manufacturer needs to increase production rate due to higher demand. Production engineer of the plant has noticed that manual handling of bottle filling process consumes significant amount of time. Therefore he suggests to introduce an automated system to fill fruit juice.

Q2 is continued to page 2

During fruit juice filling process, a nozzle should be moved-in to the bottle and it should be moved-out after filling. Engineer has decided to use cam mechanism to handle nozzle moving operation. As the plant design engineer you are required to

i) List out all parameters that are necessary to design cam profile.

[2.0 Marks]

ii) Develop a cam profile to operate the nozzle moving mechanism assuming maximum nozzle lift of 40mm.

[4.0 Marks]

Note:
Calculated time for fruit juice filling and waiting time for the next bottle are equal and it is 1/3 of total time of the filling process.

Q3 The balancing of rotating bodies is important to avoid vibration. In heavy industrial machines such as gas turbines and electric generators, vibration can cause catastrophic failure.

a) Define "balancing of rotating bodies" and type of balancing. Name five balancing application fields.

[2.0 Marks]

b) Briefly explain the significance of balancing of rotating masses in industrial applications?

[2.0 Marks]

c) A shaft has three eccentrics (A, B, C), each 80 mm diameter and 30 mm thick, machined into one piece. The central planes of the eccentrics are 55 mm apart. The distance of the centres of eccentrics from the axis of rotation are 15 mm, 22 mm and 12 mm respectively and their angular positions are 120° apart. The density of metal is 6850 kg/m^3. Find the amount of out-of-balance force and couple at 650 r.p.m. If the shaft is balanced by adding two masses at a radius of 85 mm and 120 mm from the central plane of the middle eccentric, find the values of the masses and their angular positions. Take position of mass A as vertical and reference plane as the plane of balancing mass near mass A.

[8.0 Marks]

Q4. a) Define the terms Body Centrode and Space Centrode with suitable neat sketches.

[1.0 Mark]

b) Consider the rigid body in Figure Q4(b) where magnitude and direction of the velocity vector V_A and, the magnitude of the velocity vector V_B are known. By using the knowledge of Instantaneous Centre Method find the direction of the velocity vector V_B.

[1.0 Mark]

Q4 is continued to page 3

c) The crank of a slider crank mechanism shown in Figure Q4(c) rotates clockwise at a constant speed of 350 r.p.m. The crank is 150 mm and the connecting rod is 600 mm long. Determine,

i) Linear velocity and acceleration of the point located by 2/3 length from point B of the connecting rod,

ii) Angular velocity and angular acceleration of the connecting rod at a crank angle of 45° from inner dead centre position.

(It is not necessary to produce scaled drawings. Sketch the Space Diagram, Velocity Diagram and Acceleration Diagram with respective data.)

[4.0 Marks]

d) What is the function of a governor?

[1.0 Mark]

e) What is meant by equilibrium speed of a governor?

[1.0 Mark]

f) Neatly sketch a diagram of a centrifugal governor and name the important parts.

[2.0 Marks]

g) List-out three practical applications of governors and briefly describe how governors help manoeuvre the function of particular operation.

[2.0 Marks]

Q5 a) Sate four advantages and disadvantages of gear trains compared to belt, rope and chain drivers

[3.0 Marks]

b) Briefly explain the following terms.

i) Circular pitch (p_c).

ii) The Diametral pitch (p_d).

iii) Module (m).

[3.0 Marks]

c) In an epicyclic gear train [Figure Q5], the internal wheels A and B, and compound wheels C and D rotate independently about axis O. The wheels E and F rotate on pins fixed to the arm G. E gears with A and C and F gears with B and D. All the wheels have the same module and the number of teeth: $T_C = 28$; $T_D = 26$; $T_E = T_F = 18$.

i) Find the number of teeth of wheels A and B

ii) If the arm G makes 100 r.p.m. clockwise and the wheel A is fixed, find the speed of wheel B.

iii) If the arm G makes 100 r.p.m. in clockwise and wheel A makes 10 r.p.m. in counter clockwise ; find the speed of wheel B.

[6.0 Marks]

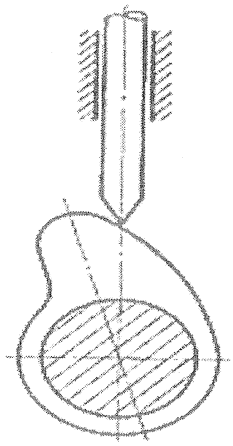

Figure Q2: Cam Mechanism

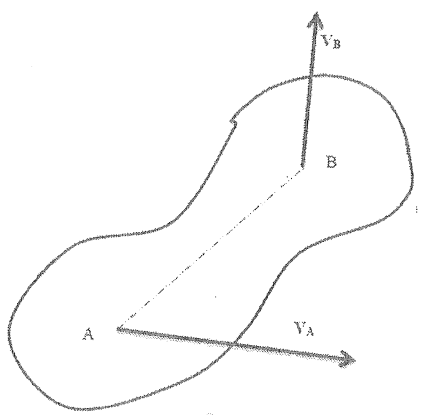

Figure Q4(b): Rigid Body

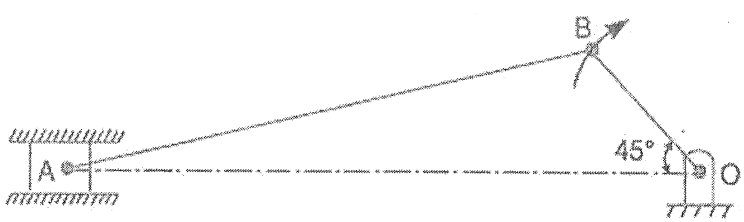

Figure Q4(c): Slider Crank Mechanism

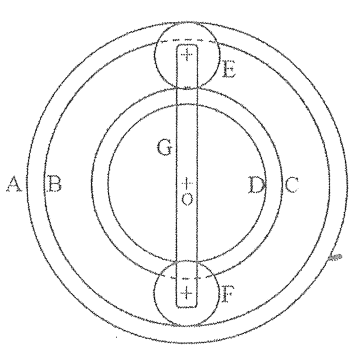

Figure Q5: Epycyclic Gear Train