UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	KINEMATICS MECHANISM
COURSE CODE	:	BDC 40303
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FOUR (4)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 **Figure Q1** shows a concept for a hand pump used for increasing oil pressure in a hydraulic line.

(a) Construct a kinematic diagram for hand pump mechanism. (5 marks)

(b) Analyze the mechanism geometry for the hand pump. (8 marks)

(c) Determine the displacement of the piston as the handle rotates 1a° counterclockwise. (12 marks)

(The value of **a** is the forth digit of your matrix number. For example, a student with the matrix number **CD170987** will have the value of **1a° = 19°**).

Q2 **Figure Q2** shows a mechanism used in production line to turn over cartons so that labels can be glued to the bottom of the carton. The driver arm is 1a inches long and, at the instant shown, it is inclined at a 6b° angle with a clockwise angular velocity of 5 rad/s. The follower link is 16 inch long. The distance between the pins on the carriage is 7 inches, and they are currently in vertical alignment.
(The value of **a** is the last digit of your matrix number and the value of **b** is the second last digit of your matrix number. For example, a student with the matrix number **CD170987** will have the value of **1a = 17** and **6b°=68°**).

(a) Construct a turnover kinematic mechanism. (5 marks)

(b) Analyze the mechanism geometry for the turnover carton. (8 marks)

(c) Determine the angular velocity of the carriage and slave arm. (12 marks)

Q3 The mechanism shown in **Figure Q3** is used to pull movie film through a projector. The mechanism is driven by the drive wheel rotating at constant 5ab rpm.

(Note that:

a = fifth digit of your matrix number

b = forth digit of your matrix number

For example, a student with the matrix number **CD170987** will have the values **5ab=589**).

(a) Construct the scaled kinematic diagram for the film advanced mechanism. Use scale of 1cm: 25 mm to analyze the velocity at point B, C and X. (12 marks)

(b) Justify the acceleration component and graphically, evaluate the acceleration at B, C and at the claw, X, which engages with the film.

(13 marks)

Q4 A planetary gear train is illustrated in **Figure Q4.** The carrier (link 2) serves as the input to the train. The sun (gear 1) is the fixed and has 30 teeth. The planet gear (gear 3) has 35 teeth. The ring gear serves as the output from the train and has **10a** teeth. Determine the rotational velocity of all members of this train when the input shaft rotates **1b00** rpm clockwise.

(Noted that: **a** = fourth digit of your matrix number; **b** = fifth digit of your matrix number. For example, a student with the matrix number **CD170987** will have the values of **10a =109** and **1b00 = 1800**).

(a) Propose solution steps based on superposition method. The steps should be explained briefly.

(6 marks)

(b) Analyze the rotational velocity of all members of this gear train.

(13 marks)

(c) Besides gears, cams are an extremely common component used in many machines. Evaluate the function of both components and state an example of each one.

(6 marks)

Q5 (a) The great majority of cams can be separated into **THREE (3)** general types. Sketch and justify these cams types with suitable configuration.

(5 marks)

(b) A cam drive is used for a mechanism incorporated in a sewing machining. The cam follower must rise outward **2a** mm with cycloidal motion in **0.2b** s, dwell for **0.3c** s, fall 10 mm with cycloidal motion in 0.3 s, dwell for 0.2 s, fall **2a** - 10 mm with cycloidal motion in 0.2 s, and then repeat the sequence, where:

a = forth digit of your matrix number

b = fifth digit of your matrix number

c = last digit of your matrix number

For example, a student with the matrix number **CD170987** will have the values of **2a = 29, 0.2b = 0.28** and **0.3c=0.37**.

(i) Determine the required speed of the cams.

(6 marks)

(ii) Graphically plot a follower displacement diagram.

(8 marks)

(iii) Evaluate the maximum velocity and acceleration of the follower.

(6 marks)

-END OF QUESTIONS –

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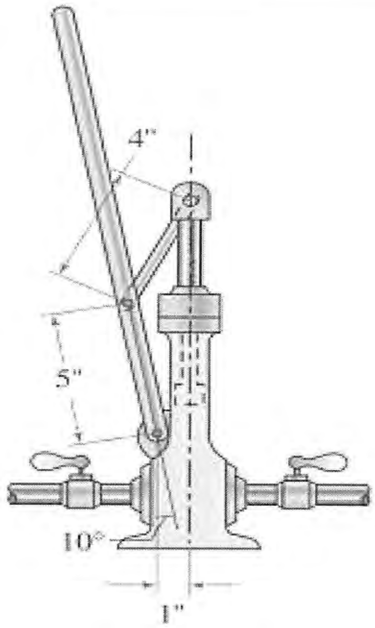

Figure Q1

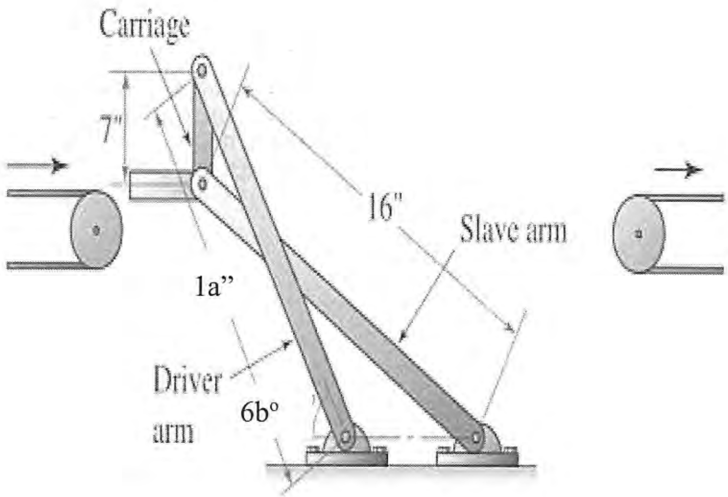

Figure Q2

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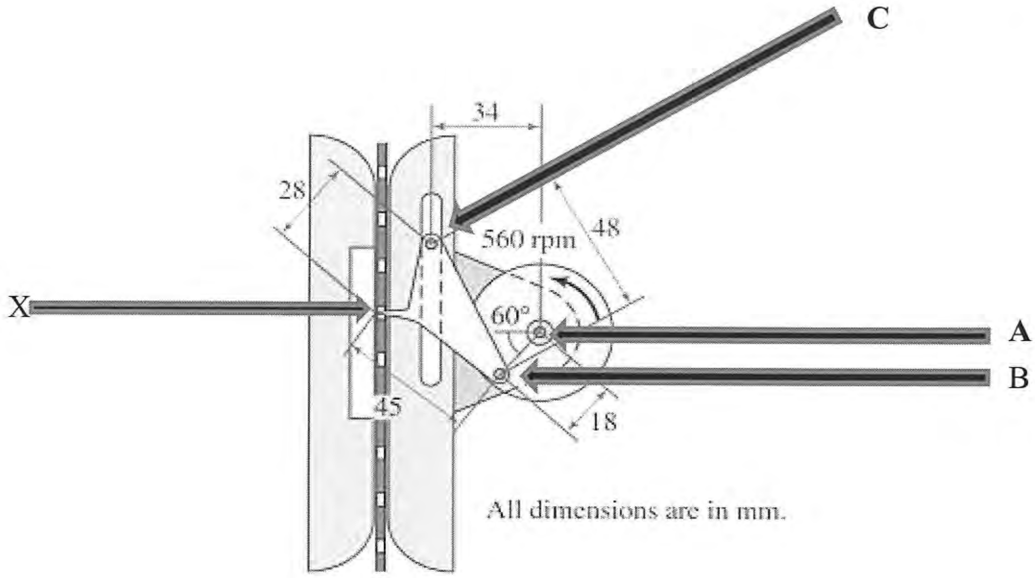

Figure Q3

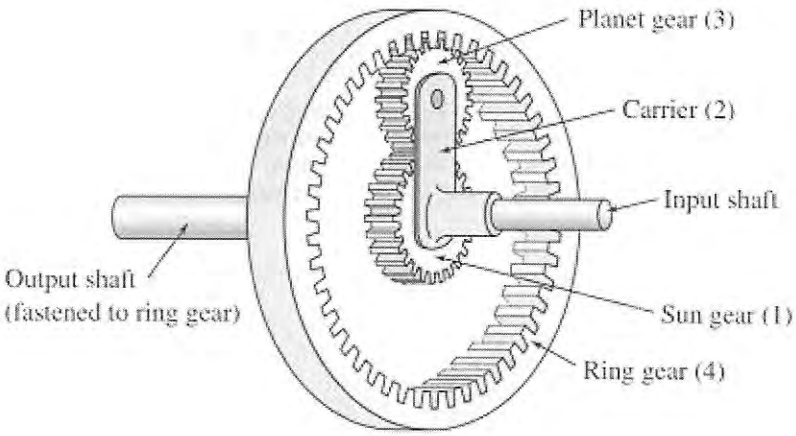

Figure Q4

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Appendix for Q5: Cam Follower Kinematics for Cycloidal Motion (Rise)

Displacement:

$$\Delta R_i = H_0 + H_i\left[\frac{t_i}{T_i} - \frac{1}{2\pi}\sin\left(\frac{2\pi t_i}{T_i}\right)\right]$$

$$= H_0 + H_i\left[\frac{\phi_i}{\beta_i} - \frac{1}{2\pi}\sin\left(\frac{2\pi\phi_i}{\beta_i}\right)\right]$$

Velocity:

$$v_i = \frac{H_i}{T_i}\left[1 - \cos\left(\frac{2\pi t_i}{T_i}\right)\right] = \frac{H_i\omega}{\beta_i}\left[1 - \cos\left(\frac{2\pi\phi_i}{\beta_i}\right)\right]$$

Acceleration:

$$a_i = \frac{2\pi H_i}{T_i^2}\left[\sin\left(\frac{2\pi t_i}{T_i}\right)\right] = \frac{2\pi H_i\omega^2}{\beta_i^2}\left[\sin\left(\frac{2\pi\phi_i}{\beta_i}\right)\right]$$

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Appendix for Q5: Cam Follower Kinematics for Cycloidal Motion

(Drop)

Displacement:

$$\Delta R_j = H_F + H_j\left[1 - \frac{t_j}{T_j} + \frac{1}{2\pi}\sin\left(\frac{2\pi t_j}{T_j}\right)\right]$$
$$= H_F + H_j\left[\frac{\phi_j}{\beta_j} - \frac{1}{2\pi}\sin\left(\frac{2\pi\phi_j}{\beta_j}\right)\right]$$

Velocity:

$$v_j = \frac{-H_j}{T_j}\left[1 - \cos\left(\frac{2\pi t_j}{T_j}\right)\right] = \frac{-H_j\omega}{\beta_j}\left[1 - \cos\left(\frac{2\pi\phi_j}{\beta_j}\right)\right]$$

Acceleration:

$$a_j = \frac{-2\pi H_j}{T_j^2}\left[\sin\left(\frac{2\pi t_j}{T_j}\right)\right] = \frac{-2\pi H_j\omega^2}{\beta_j^2}\left[\sin\left(\frac{2\pi\phi_j}{\beta_j}\right)\right]$$