UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	KINEMATICS MECHANISM
COURSE CODE	:	BDC 40303
PROGRAMME	:	**BDD**
DATE	:	JUNE/JULY 2016
DURATION	:	3 HOURS
INSTRUCTIONS	:	PART A: ANSWER **ALL** QUESTIONS PART B: ANSWER **ONE** QUESTION **ONLY**

THIS PAPER CONSIST OF **SEVEN (7)** PAGES

PART A: Answer **ALL** questions.

Q1 The system illustrated in **Figure Q1** is a device to close the top flaps of boxes.

(a) Draw the kinematics diagram of the system then identify the links, the number kinematic points and calculate the mobility of the mechanism.

(5 marks)

(b) By considering the dimentions as written in **Figure Q1**, draw the position of all links when the initial position AB is at horizontal in 0 agle (B on the right side of A)

(5 marks)

(c) If the angular velocity of crank AB is at constant 100 RPM, find the direction and the magnitude of the velocity of point C at the position as informed in **Q1(b)**, by using graphical method.

(10 marks)

Q2 The parameters to define the follower motions according to Sine Constant Cossine Acceleration (SCCA) are b, c, d and c_a . The rising function has been coded in SMath, as shown in **Figure Q2** that can be used to plot the SCCA function.

(a) If you want to investigate several functions as listed in the **Table Q2** below:

Table Q2: SCCA parameter values

Function	b	c	d	Ca
Constant acceleration	0.00	1.00	0.00	4.0000
Modified trapezoid	0.25	0.50	0.25	4.8881
Simple harmonic	0.00	0.00	1.00	4.9348
Modified sine	0.25	0.00	0.75	5.5280
Cycloidal displacement	0.50	0.00	0.50	6.2832

Design the SMath plot employing the SMath code to compare the follower motions of different functions in a single plot.

(10 marks)

(b) By looking at the codes, explain the zones of SCCA function.

(5 marks)

(c) Explain in brief how to modify the codes for falling motion of SCCA function. Give an example for the first zone only.

(5 marks)

Q3 Four configurations of slider motions and the rotation of the cranks are shown in **Figure Q3**.

(a) Indicate the direction of corriolis acceleration in each case and write the vector equation of corriolis acceleration of slider.

(10 marks)

(b) Draw the kinematic diagram of followers based on the position.

(5 marks)

(c) Draw the kinematic diagram of followers based on the shape.

(5 marks)

Q4 The carrier (link 2) in **Figure Q4** serves as the input to the train. Gear 2 is the fixed gear and has 48 teeth, gear 1 has 24 teeth, gear 3 has 25 teeth, and gear 4 has 35 teeth.

(a) By using tabular method, propose three steps approach to find the rotational direction and the values of all gears.

(5 marks)

(b) Implementing the propose steps in **Q4(a)**, determine the rotation and the rotational direction of all members, if the input shaft rotates at 900 RPM (clockwise).

(15 marks)

PART B : Answer **ONE** question **ONLY.**
(Q5 and Q6 use the same Figure Q5)

Q5 The horizontal component velocity of the connecting rod (point 2) of an engine are recorded and presented in **Figure Q5.**

(a) Since the force acting on the bearing of the connecting rod will be investigated, you are required to propose a calculation approach to do the investigation of the force in the acceleration parameter. Explain your proposal to do the investigation, write the equation for the calculation of the acceleration variable for force investigation.

(5 marks)

(b) Based on the velocity data, predict the positive and negative **zones** of acceleration.

(5 marks)

(c) Based on your proposed equation, calculate the acceleration when time 1s, 10s and 35s. Explain a brief how you can verify the calculation results related to the positive/negative zones of the acceleration.

(10 marks)

Q6 The horizontal component velocity of the connecting rod (point 2) of an engine are recorded and presented in **Figure Q5**. The crank engine rotates at 3.316 RPM constant.

(a) If you want to simulate the mechanism by using SAM, what is the values you use in the input motion for the parameters: ***Motion***, ***Time*** and ***Interval***. Plot also the angle, angular velocity and angular acceleration. Make sure you mention the units.

(5 marks)

(b) Based on the engine illustration as shown in **Figure Q5**, draw an illustration only for the crank slider mechanism.

(5 marks)

(c) If the length of crank is L1 and the connecting rod is L2, propose an equation to calculate the velocity of the piston based on floating link analysis. The crank rotates ω counter clock wise direction. Assume all angles with variables.

(10 marks)

- END OF QUESTION -

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A : (0, 0) mm
F should be located at the same level as A (at y = 0 mm)

AB : 50 mm
AD : 300 mm
AC: 200 mm
CD : 250 mm
EF: 300 mm

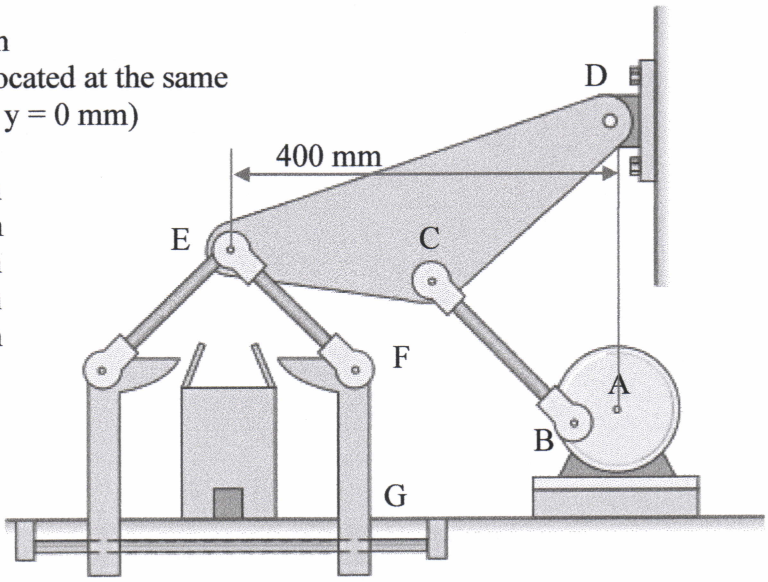

Figure Q1

$$\Delta R(\theta, b, c, d, C_a) := \text{if } \left(\theta \le \frac{b}{2}\cdot\beta\right) \wedge (b \ne 0) \wedge (\theta > 0)$$

$$C_a \cdot H_i \cdot \left[\frac{b}{\pi\cdot\beta}\cdot\theta - \left(\frac{b}{\pi}\right)^2 \cdot \sin\left(\frac{\theta}{b\cdot\beta}\cdot\pi\right)\right]$$

else

$$\text{if } \left(\theta \ge \frac{b}{2}\cdot\beta\right) \wedge \left(\theta \le \frac{1-d}{2}\cdot\beta\right)$$

$$C_a \cdot H_i \cdot \left[\frac{\theta^2}{2\cdot\beta^2} + b\cdot\left(\frac{1}{\pi} - \frac{1}{2}\right)\cdot\frac{\theta}{\beta} + b^2\cdot\left(\frac{1}{8} - \frac{1}{\pi^2}\right)\right]$$

else

$$\text{if } \left(\theta \ge \frac{1-d}{2}\cdot\beta\right) \wedge \left(\theta \le \frac{1+d}{2}\cdot\beta\right) \wedge (d \ne 0)$$

$$C_a \cdot H_i \cdot \left[\left(\frac{b}{\pi} + \frac{c}{2}\right)\cdot\frac{\theta}{\beta} + \left(\frac{d}{\pi}\right)^2 + b^2\cdot\left(\frac{1}{8} - \frac{1}{\pi^2}\right) - \frac{(1-d)^2}{8} - \left(\frac{d}{\pi}\right)^2\cdot\cos\left[\frac{\pi}{d}\cdot\left(\frac{\theta}{\beta} - \left(\frac{1-d}{2}\right)\right)\right]\right]$$

else

$$\text{if } \left(\theta \ge \frac{1+d}{2}\cdot\beta\right) \wedge \left[\theta \le \left(1 - \frac{b}{2}\right)\cdot\beta\right]$$

$$C_a \cdot H_i \cdot \left[-\frac{\theta^2}{2\cdot\beta^2} + \left(\frac{b}{\pi} + 1 - \frac{b}{2}\right)\cdot\frac{\theta}{\beta} + \left(2\cdot d^2 - b^2\right)\cdot\left(\frac{1}{\pi^2} - \frac{1}{8}\right) - \frac{1}{4}\right]$$

else

$$\text{if } \left[\theta \ge \left(1 - \frac{b}{2}\right)\cdot\beta\right] \wedge (\theta \le \beta) \wedge (b \ne 0)$$

$$C_a \cdot H_i \cdot \left[\frac{b\cdot\theta}{\pi\cdot\beta} + 2\cdot\frac{\left(d^2 - b^2\right)}{\pi^2} + \left[\frac{(1-b)^2 - d^2}{4}\right] - \left(\frac{b}{\pi}\right)^2\cdot\sin\left[\frac{\pi}{b}\cdot\left(\frac{\theta}{\beta} - 1\right)\right]\right]$$

else

$$0$$

Figure Q2

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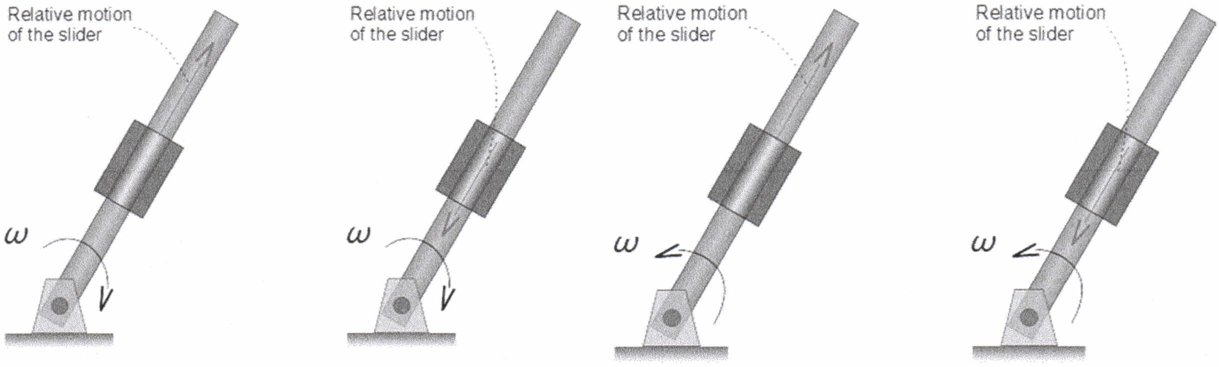

Figure Q3

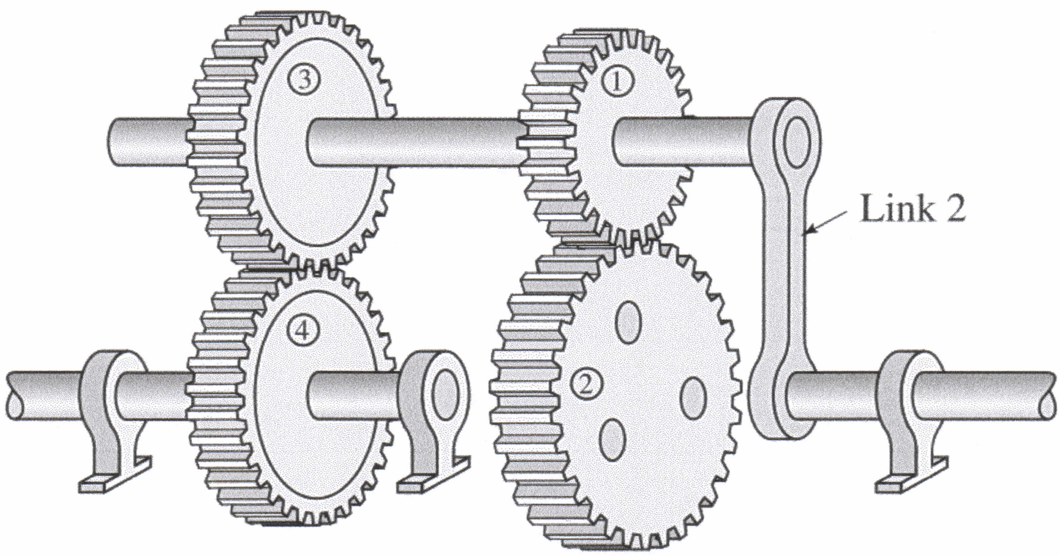

Figure Q4

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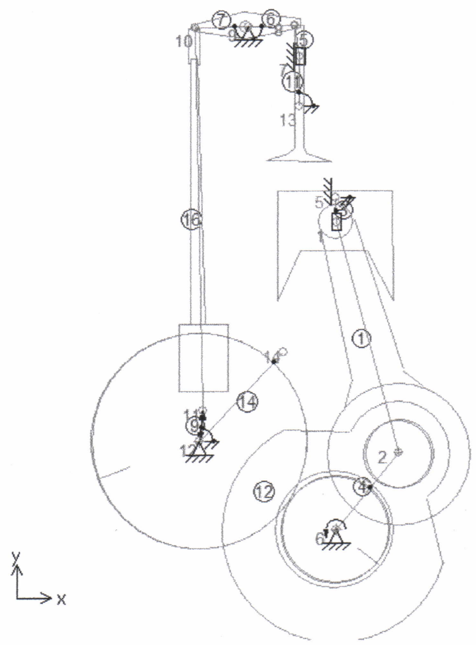

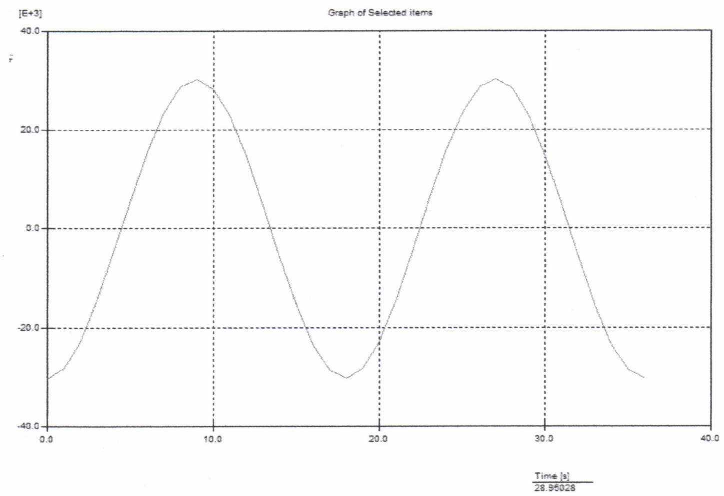

Result listing SAM 6.1.55 . Mechanism: MOTOR

Nr: [-]	Time [s]	Vx(2) [mm/s]	Nr: [-]	Time [s]	Vx(2) [mm/s]
0	0	-30227.412			
1	1	-28193.613	19	19	-28228.2
2	2	-22762.66	20	20	-22825.9
3	3	-14588.949	21	21	-14673.2
4	4	-4657.361	22	22	-4752.45
5	5	5835.41	23	23	5740.927
6	6	15625.051	24	24	15542.56
7	7	23531.971	25	25	23471.41
8	8	28603.435	26	26	28572.11
9	9	30228.365	27	27	30230.04
10	10	28210.966	28	28	28245.44
11	11	22794.322	29	29	22857.45
12	12	14631.105	30	30	14715.27
13	13	4704.932	31	31	4800
14	14	-5788.156	32	32	-5693.64
15	15	-15583.808	33	33	-15501.2
16	16	-23501.709	34	34	-23441
17	17	-28587.8	35	35	-28556.3
18	18	-30229.24	36	36	-30230.8

Figure Q5

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