UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION

SEMESTER I

SESSION 2022/2023

COURSE NAME	:	MECHATRONIC MECHANISM
COURSE CODE	:	BEJ 44803
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1.ANSWER ALL QUESTIONS
		2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.
		3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

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

Q1 (a) (i) Define mechanism in mechanical engineering.

(1 mark)

(ii) Describe the engineering principles in mechanics, dealing with motion, time, and forces.

(3 marks)

(iii) Explain planar mechanism.

(1 mark)

(iv) Give **TWO (2)** examples of planar mechanism in applications.

(2 marks)

(b) The main purpose of mechanism is to exhibit motion such that a target spot or path could be achieved.

(i) Explain the meaning of mobility of a mechanism.

(2 marks)

(ii) Critique the meaning of mobility if the index number is $m > 0$ or $m = 0$ or $m < 0$.

(3 marks)

(iii) Sketch the kinematic diagram of the linkages shown by **Figure Q1(b).**

(4 marks)

(iv) Recommend the number of input based on the mobility of the mechanism shown by **Figure Q1(b)**, by applying Kutzbach Criterion.

(4 marks)

(c) **Figure Q1(c)** shows a crank 50 mm radius which rotates at 2000 rev/min anticlockwise. Analyze the velocity of the piston for the position shown and the angular velocity of link AB about A.

(5 marks)

Q2 (a) (i) Define gears in power transmission system.

(2 marks)

(ii) State the purposes of using gears in power transmission system.

(3 marks)

(b) A simple gear train has **two (2)** spur gears. The input gear has 20 teeth and the output gear has 100 teeth. The input rotates at 2000 rev/min clockwise.

(i) Analyze the gear ratio and the output speed.

(2 marks)

(ii) The input torque is 15Nm and the efficiency is 65%. Analyze the output power and the holding torque.

(4 marks)

(c) A compound gear train is showed in **Figure Q2(c)**. Gear A is the input and revolves at 1200rev/min clockwise viewed from the left end. The input torque is 30Nm and the efficiency is 70% in which:

Gear A has 50 teeth

Gear B has 150 teeth

Gear C has 40 teeth

Gear D has 80 teeth

Analyze the following:

(i) The output speed and its direction.

(2 marks)

(ii) The output power and holding torque

(4 marks)

(d) An epicyclic gear box shown in **Figure Q2(d)** has a fixed outer gear C with 240 teeth. The planet gears have 20 teeth. The input is the arm/cage A and the output is the sun gear D.

(i) Analyze the number of teeth on the sun gear.

(2 marks)

(ii) Analyze the ratio of the gear box using Tabular Method.

(4 marks)

(iii) From the results above, judge the output performance on speed, direction, and torque.

(2 marks)

Q3 (a) (i) Compare the use of power transmission system between a gear system and a belt drive system.

(4 marks)

(ii) Demonstrate open belt drive and cross belt drive.

(4 marks)

(iii) A belt embraces the shorter pulley by an angle 145° and run at speed of $2400m/min$. Dimension of the belt are width, $25cm$ and thickness, $10mm$. Its density is $1gm/cm^3$. Analyze the maximum power that can be transmitted at the above speed, if the maximum permissible stress in the belt in not to exceed $250N/cm^2$ and friction coefficient is 0.25.

(6 marks)

(b) A shaft runs at 80 rpm and drives another shaft at 150 rpm through belt drive. The diameter of the driving pulley is 600mm. Investigate the diameter of the driven pulley if these conditions are taken:

(i) Neglecting belt thickness.

(2 marks)

(ii) Taking belt thickness as 5 mm.

(2 marks)

(iii) Assuming for case **Q3(b)((ii)** a total slip of 4%.

(2 marks)

(iv) Assuming for case **Q3(b)((ii)** a slip of 2% on each pulley.

(2 marks)

(c) Conclude the conditions given in **Q3(b)** in practical usage.

(3 marks)

Q4 (a) (i) Describe the physical phenomena if a rotating shaft as shown in **Figure Q4(a)** is "unbalanced".

(3 marks)

(ii) Explain the physic of the phenomena illustrated in **Q4(a)(i)**.

(4 marks)

(b) Analyze the 4th mass that should be added at a radius of 50mm in order to statically balance a system consist of multiple masses in the same plane. Given that:

- Mass A is 1kg at 100mm radius.
- Mass B is 1.5kg at 75mm radius.
- Mass C is 2.0kg at 90mm radius.
- The angles between Mass A and B is 45° ; Mass A and C is 165°.

(4 marks)

(c) The planes as shown in **Table Q4(c)** containing masses B and C is 400 mm apart. The angle between planes containing B and C is 90°. B and C make angles of 200° and 110° respectively with D in the same sense. Analyze:

(i) The distance between planes A and B, and planes A and D.

(6 marks)

(ii) The magnitude and the angular position of mass A.

(4 marks)

(d) Illustrate the procedures of car tire balancing using a balancing machine.

(4 marks)

- END OF QUESTIONS –

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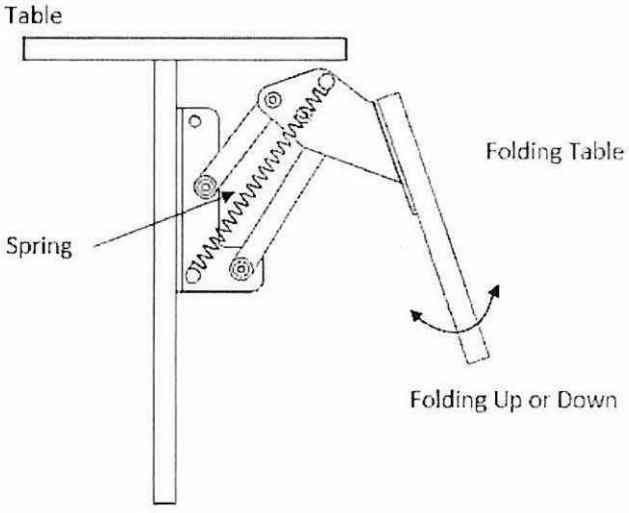

Figure Q1 (b)

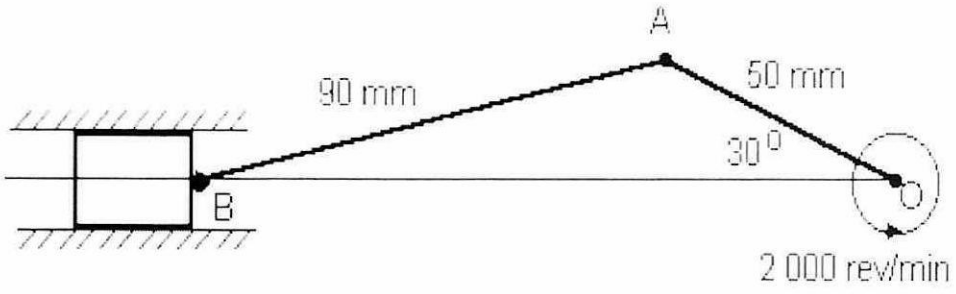

Figure Q1 (c)

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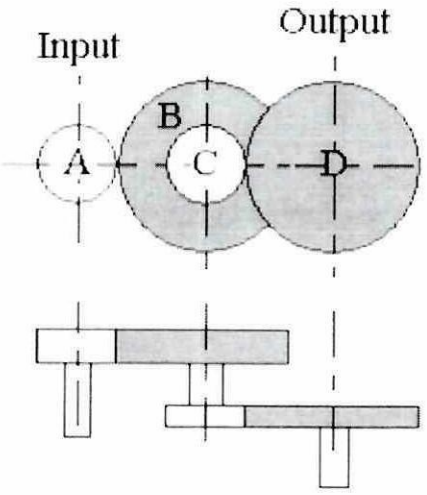

Figure Q2 (c)

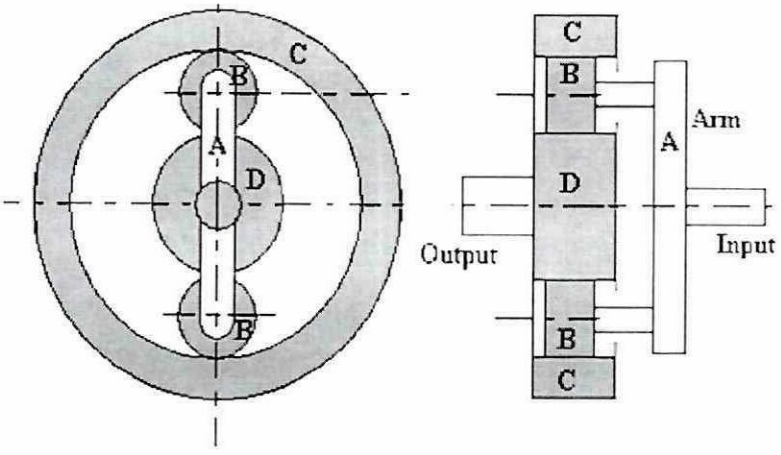

Figure Q2 (d)

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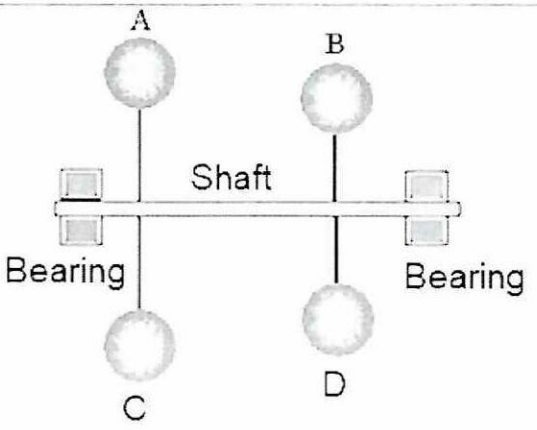

Figure Q4 (a)

Table Q4 (c)

	A	B	C	D
Mass (kg)	M_A	60	50	80
Radius (mm)	180	240	120	130