UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	MECHATRONIC MECHANISM
COURSE CODE	:	BEH 41103
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS PAPER CONSISTS OF SEVEN (7) PAGES

TERBUKA

Q1 (a) Differentiate between Rigid Body and Structure.

(1 mark)

(b) Describe the purpose of mechanism and give **TWO (2)** examples of mechanism in applications.

(3 marks)

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

    (i) Define mobility of a mechanism.

(1 mark)

    (ii) Criticize if a mechanism has mobility, m = 2, m = 0, m=-1.

(3 marks)

    (iii) Draw the kinematic diagram of the linkages shown by **Figure Q1(c).**

(4 marks)

    (iv) Calculate mobility of the mechanism shown by **Figure Q1(c).**

(4 marks)

(d) **Figure Q1(d)** shows a "rocking lever" mechanism. AD is fixed and is 150mm long. The crank AB is 40mm long and rotates at 120rpm clockwise, while the link CD = 80mm oscillates about D. BC and AD are equal of length. Find the angular velocity of link CD when angle $\angle BAD = 60°$.

(4 marks)

Q2 (a) Power transmission consisted of gear systems and belting system is inevitably designed and included in powered mechanism such as car, machines, automation etc.

    (i) Explain the main purpose of applying gear systems in a powered mechanism.

(2 marks)

    (ii) Name four different types of gear systems.

(2 marks)

    (iii) An epicyclic gear box is as **Figure Q2(a)**. An epicyclic gear box has a fixed outer gear C with 260 teeth. The planet gears have 30 teeth. The input is the arm/cage A and the output is the sun gear D. Calculate the number of teeth on the sun gear and the ratio of the gear box.

(6 marks)

2

(b) Power Transmission (Belting)

    (i)   Compare the use of power transmission system between gear systems and belting systems.

(2 marks)

    (ii)   Describe open belt drive and crossed belt drive.

(2 marks)

    (iii)   A belt embraces the shorter pulley by an angle 145° and run at speed of $2400m/min$. Dimensions of the belt are: width, $25cm$ and thickness, $10mm$. Its density is $1gm/cm^3$. Inquire 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)

Q3   (a)   Identify the importance of balancing of rotating parts necessary for high speed engines.

(2 marks)

    (b)   Illustrate the working principles of static balancing and dynamic balancing.

(4 marks)

    (c)   Four masses m1, m2, m3 and m4 at radii of 225 mm, 175 mm, 250 mm and 300 mm are connected at angles of 0°, 45°, 75°, 120° from horizontal line. If the shaft rotates at 500 rpm, find what unbalanced force acts upon the shaft and at what angle from mass m1. If a mass to balance the system can be placed at a radius of 200 mm, find the weight of the mass. Assume m1= 1000kg , m2= 1500kg, m3= 1200kg and m4= 800kg.

(4 marks)

    (d)   Four masses A, B, C and D in different planes as shown in **Table Q3(d)** are to be completely balanced. The planes containing masses A and B is $100mm$ apart while B and C are $300mm$ apart. The angle between planes containing B and C is 90°. Analyze:

    (i)   The position of planes A and D.

(4 marks)

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

(2 marks)

    (e)   Compose the procedures of balancing using a balancing machine.

(4 marks)

Q4 (a) Discuss briefly the various types of friction experienced by a body.

(4 marks)

(b) In a screw jack, the helix angle of thread is α and the angle of friction is φ. Prove that its efficiency is maximum, when $2\alpha = (90° - \varphi)$.

(5 marks)

(c) An electric motor driven power screw moves a nut in a horizontal plane against a force of $75kN$ at a speed of $300mm/min$. The screw has a single square thread of $6mm$ pitch on a major diameter of $40mm$. The coefficient of friction at the screw threads is 0.1.

   (i) Determine the mean diameter of the screw.

(2 marks)

   (ii) Calculate the force required at the circumference of the screw.

(4 marks)

   (iii) Analyze the torque required to overcome friction.

(2 marks)

   (iv) Estimate the power of the motor.

(3 marks)

Q5 (a) Explain the terms of 'free vibration', 'forced vibration' and 'damped vibration'.

(3 marks)

(b) A mass of $4kg$ is suspended from a spring and oscillates up and down at $2Hz$.

   (i) Find the stiffness of the spring.

(2 marks)

   (ii) The amplitude of the oscillation is $5mm$. Determine the displacement, velocity and acceleration at $0.02s$ after the mass passes through the mean or rest position in an upwards direction.

(6 marks)

(c) The measurements on a mechanical vibrating system show that it has a mass of $8kg$ and the springs can be combined to give an equivalent spring stiffness $5.4N/mm$. If the vibrating system have a dashpot attached with exerts a force of $40N$ when the mass has a velocity of $1m/s$. Determine:

(i)   Critical damping coefficient.

(2 marks)

(ii)   Damping ratio.

(2 marks)

(iii)   Logarithmic decrement.

(2 marks)

(iv)   Ratio of two consecutive amplitudes.

(3 marks)

- END OF QUESTIONS -

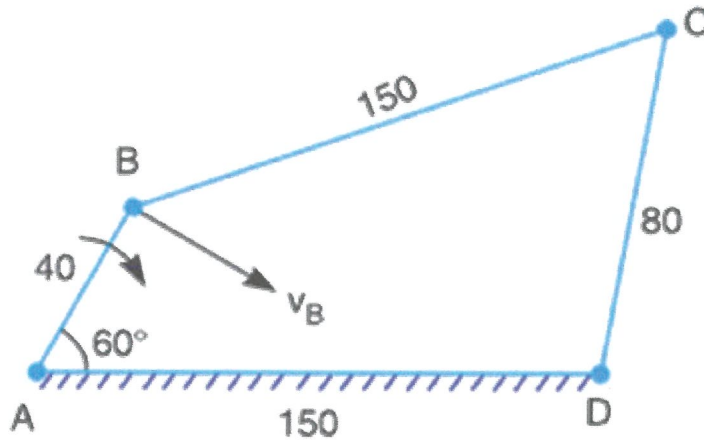| FINAL EXAMINATION			
SEMESTER/SESSION	: SEM I/20187/2019	PROGRAMME CODE	:BEJ
COURSE NAME	: MECHATRONIC MECHANISM	COURSE CODE	:BEH41103

Figure Q1 (c)

Figure Q1 (d)

FINAL EXAMINATION			
SEMESTER/SESSION	: SEM I/2018/2019	PROGRAMME CODE	:BEJ
COURSE NAME	: MECHATRONIC MECHANISM	COURSE CODE	:BEH41103
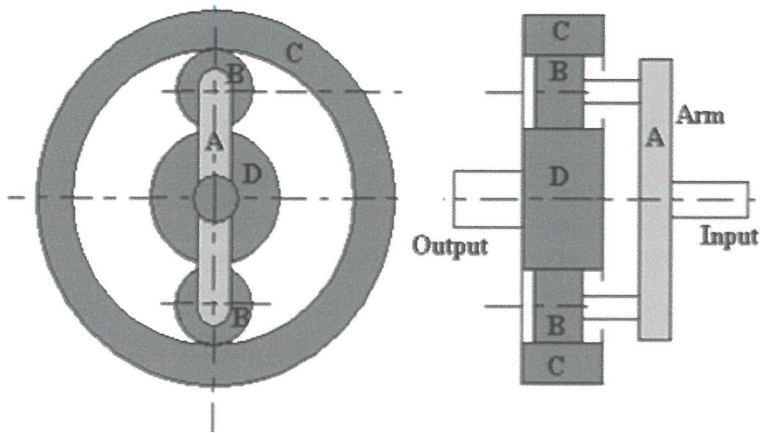
Figure Q2 (a)

Table Q3 (d)

	A	B	C	D
Mass (kg)	*unknown*	30	50	40
Radius (mm)	180	240	120	150

CONFIDENTIAL