(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 242

COURSE TITLE: MECHANICS OF MACHINES II

DATE: Friday 14th April, 2023 **TIME:** 8: 00–10: 00 am

INSTRUCTIONS TO CANDIDATES

This paper contains **FOUR** Questions
Answer **question ONE (1)** and any **OTHER TWO** questions

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

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1. (a) Using kinematic diagram, explain the **second** inversion of the crank-slider mechanism and show how it is applied in whits worth quick return mechanism. (4 Marks)

(b) With reference to gears, explain the meaning of the following terms : -

(i) Diametral pitch (ii) Circular pitch (iii) clearance (6 marks)

(c) With reference to toothed gears, define the term Pressure angle (φ) (2 marks)

(d) Define the following terms (i) Mechanism and (ii) Machine (4 marks)

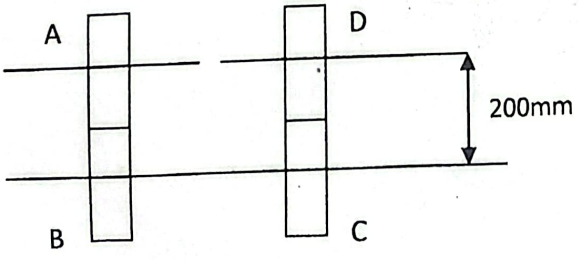
(e) A gear box has an input speed of 1500 rev/min clockwise and an output speed of 300 rev/min anticlockwise. The input power is 20kW and the efficiency is 70%. Determine: - (i) the gear ratio (ii) the input torque (iii) the output power (iv) the output torque (6 marks

(f) In a crank-slider mechanism, the radius of the crank and length of the connecting rod are 300 mm and 1200 mm respectively. The crank is rotating at 200 r.p.m. Find the velocity and acceleration of the piston, when the crank angle is 50° from the inner dead centre. Find also crank angle at which the velocity is maximum and the maximum velocity. (8 marks)

2. (a) Define corriolis component of acceleration giving its expression, Use a diagram to explain the situation that makes it to be present in mechanisms (5 marks)

(b) The speed ratio of the reverted gear train, as shown below is to be 12. The module pitch of gears A and B is 3.125 mm and of gears C and D is 2.5 mm. Calculate the suitable numbers of teeth for the gears. No gear is to have less than 24 teeth. (10 marks)

(c) The rigid link shown in **Fig. Q2** is subjected to a force P and a torque T about its center of gravity (c.o.g), G. This system can be substituted with a dynamically equivalent system with only P acting, in the same direction at a distance e from the G. Show how this can be achieved and express e in terms of the link's radius of gyration *k* and linear acceleration of G of the link, a_G (5 marks)



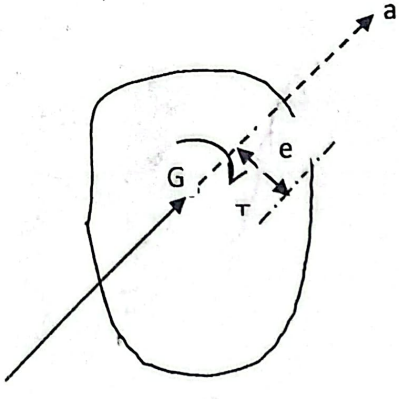


Fig. 2

3. (a) A connecting rod of mass 6 kg and length between end centers of 500mm is to be replaced by a dynamically equivalent system of two concentrated masses placed to coincide with the end centers of the rod. If the c.o.g of the connecting rod is 200 mm from the big end center, and the radius of gyration of the connecting rod is 180 mm about an axis through G, find the magnitude of the two masses. What is the correction couple that will be required for dynamic equivalent at an angular acceleration α of 150 rad/s^2 of the rod? State its sense in relation to α (8 marks)

(b) A horizontal double-acting steam engine, 0.3 m in diameter and 0.5 m stroke, has an equivalent mass of 100 kg for the reciprocating parts. The engine runs at 200 r.p.m. The gas pressure when the crank has turned 45° from the inner dead centre (i.d.c) is 1 MN/m^2 and the back pressure is 35 kN/m^2. The ratio of the connecting rod length to the radius of the crank is 4. Find, for the above data (i) piston effort, and (ii) turning moment on the crankshaft (12 marks)

4. (a) In an epicyclic gear train, an arm carries two gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 r.p.m. in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed, makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B? Solution: Given: TA = 36; TB = 45; NC = 150 r.p.m. (anticlockwise). (10 marks)

(b) A vertical steam engine has a bore of 15 cm and stroke of 30 cm. The connecting rod is 60 cm long and the mass of the reciprocating parts is 30 kg and the engine is running at 240 r.p.m. When the crank is 60° past its top dead centre, the steam pressure on the cover end side of the piston is 6 bar, while that on the crank side is 1 bar. Neglecting the area of the piston rod and determine:

(i) net force on the piston rod, and

(ii) the turning moment on the crank shaft.

(iii) The net force on the cylinder wall (10 marks)

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UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE OF B.SC MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 272

COURSE TITLE: THERMODYNAMICS II

DURATION: 2 HOURS

DATE: 19/04/2023 **TIME:** 12:00 – 14:00 HRS

INSTRUCTIONS TO CANDIDATES

(i) Answer **Question 1 (Compulsory)** and any other **TWO** questions
(ii) All symbols have their usual meaning
(iii) Use steam tables provided

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QUESTION ONE (Compulsory) – 30 Marks

a) Define the following terms:

(i) Mixture strength. **(3 Marks)**

(ii) Proximate analysis. **(3 Marks)**

b) Use a t-s diagram to explain the processes in an Otto cycle. **(8 Marks)**

c) Describe the processes in a Joule-Brayton cycle using a p-v diagram **(8 Marks)**

d) Give the firing order for the following engines:

(i) V6 **(2 Marks)**

(ii) V8 **(2 Marks)**

e) Give two differences between a spark-ignition engine and a compression-ignition engine. **(4 Marks)**

QUESTION TWO (20 Marks)

An oil engine based on an Ackroyd-Stuart combustion cycle operates with an inlet pressure and temperature of 1bar and 18^0C respectively, a maximum pressure of 72bar, and a compression ratio of 15. The heat supplied during the isochoric process is the same as the heat supplied during the isobaric process.

a) Sketch the p-v diagram for the engine cycle. **(3 Marks)**

b) Calculate the air standard thermal efficiency. **(11 Marks)**

c) Determine the mean effective pressure. **(6 Marks)**

QUESTION THREE (20 Marks)

Ethyl alcohol (C_2H_6O) is burned in a petrol engine with exhaust mixture strengths of 110%.

a) Calculate the:

i) Stoichiometric air/fuel ratio.

(4 Marks)

ii) Actual air/fuel ratio.

(2 Marks)

b) Determine the analysis by volume of the products in the exhaust gas at the given mixture strength on a dry basis.

(8 Marks)

c) What volume of the mixture per kg of fuel at a temperature of 60°C and a pressure of 2 bar would be required for the stoichiometric mixture?

(3 Marks)

d) Calculate the actual volume of products of combustion per kg of fuel after cooling to a temperature of 110°C at 1.8 bar.

(3 Marks)

QUESTION FOUR (20 Marks)

A steam power plant operates on a Rankine cycle with reheat between a boiler pressure of 42bar and a condenser pressure of 0.035bar. The steam entering the turbine is initially superheated at 500°C. When the steam is expanded in the turbine to a pressure of 2.3bar, it is reheated to 500°C and thereafter allowed to expand to a pressure of 0.035bar.

Neglecting feed-pump work, calculate the:

a) Cycle efficiency.

(15 Marks)

b) Work ratio.

(2 Marks)

c) Specific steam consumption.

(3 Marks)

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MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY

[MMUST]

MAIN EXAMINATION

2022/2023 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 232

COURSE TITLE: FLUID MECHANICS II

DATE: 18-04-2023 **TIME: 08:00-10:00**

INSTRUCTIONS TO CANDIDATES

1. This paper consists of **FOUR** questions
2. Answer Question **ONE [Compulsory]** and any other **TWO** Questions
3. All symbols have their usual meaning

TIME: 2 Hours

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QUESTION ONE [30 marks]

a] Write Bernoulli's equation in the **pressure form**, and use the MLT system to prove and comment on the homogeneity of the equation. **[4 marks]**

b] Express Newton's second law of motion for rotating bodies. What can you say about the angular velocity and angular momentum of a rotating non-rigid body of constant mass if the net torque acting on it is zero. **[4 marks]**

c] A nozzle that discharges a 60-mm-diameter water jet into the atmosphere is on the right end of a horizontal 120-mm-diameter pipe. The water velocity and guage pressure in the pipe is 4 m/s and 400 kPa respectively. Determine the magnitude and direction of resultant axial force the water exerts on the nozzle. **[10 marks]**

d] A test is to be performed on a proposed design for a large pump that is expected to deliver 1.8 m^3/s of water from a 50 cm diameter impeller with a pressure rise, ΔP of 380 kPa. A model with a 7 cm diameter is to be used. The model fluid is at the same temperature as the one in the prototype. Taking Reynolds and Euler numbers as the appropriate dimensionless parameters, determine the: **[i]** flow rate that should be used **[ii]** expected pressure rise **[12 marks]**

QUESTION TWO [20 marks]

Consider a fluid flowing through a horizontal pipe of circular cross-section. The pressure gradient [pressure per unit Length], $\mathbf{dP_G}$ is a function of fluid density $\boldsymbol{\rho}$, flow velocity **V**, pipe diameter **D**, surface roughness $\boldsymbol{\varepsilon}$ and fluid viscosity, $\boldsymbol{\mu}$. Using the Buckingham Pi Theorem, determine a suitable set of dimensionless parameters (and name them) that can be used in this study. For consistency, choose D rather than ε as one of the repeating variables **[20 marks]**

QUESTION THREE [20 marks]

A reducing elbow is used to deflect water flow upward by an angle $\theta=45°$. The diameter of the elbow reduces from 600 mm at the inlet to 300 mm at the outlet. The guage pressure at the inlet is 140 kPa and the volume flow rate of water is 0.425 m^3/s. As the fluid flows around the bend, it will exert a force which will need to be counterbalanced in order to hold the pipework in place. Ignoring frictional forces, and assuming the pipe bends in the horizontal plane, determine the magnitude and direction of the force exerted by the fluid on the pipe. **[20 marks]**

QUESTION FOUR [20 marks]

a] The volume flow rate of flow, Q, through a pipe containing a slowly moving liquid is given by the equation

$$Q = \frac{\pi R^4 \Delta P}{8 \mu L}$$

Where R is the pipe radius, ΔP the pressure drop along the pipe, μ a fluid viscosity and L the length of the pipe. What are the dimensions of the constant $\frac{\pi}{8}$. Would you classify this equation as a general homogeneous equation? Explain **[6 marks]**

b] The water system shown in **Fig.Q4b** carries a discharge of 0.25 m^3/s. The friction factor f is 0.02 while the minor loss coefficients at the entrance, 45° elbow and exit are 0.5, 0.4 and 1 respectively. **[12 marks]**

i. Determine the head added by the pump
ii. If the efficiency of the pump is 82 %, calculate the power input required by the pump to maintain the flow **[2 marks]**

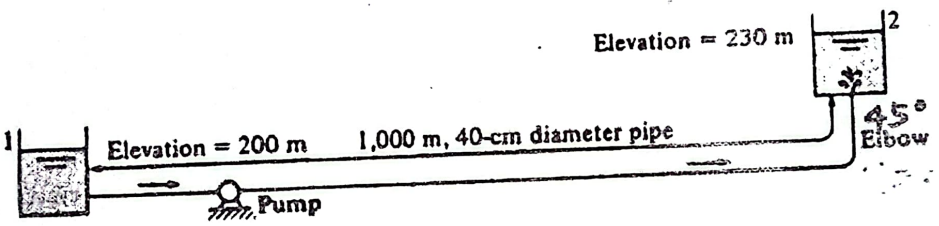

Fig.Q4b

.....The End.....

General information

Standard acceleration: g= 9.81 m/s^2 *Standard atmospheric pressure*: 1 atm=101.325 kPa= 760 mmHg=10.33 mH_2O

1 bar=10^5 Pa

Specific gas constant of air: R= 0.287 kJ/kg. K

Universal gas constant: R_U = 8.314 kJ/kmol K

Dynamic viscosity μ: **1** $kgm^{-1}s^{-1}$ = **1** N s m^{-2} = **1** Pa.s

Kinematic viscosity: m^{-2} /s

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(MAIN CAMPUS)

UNIVERSITY MAIN EXAMINATIONS

2022/2023 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN MIE, CSE AND ECE.

COURSE CODE: MAT 202 E

COURSE TITLE: ENGINEERING MATHEMATICS II

DATE: TUESDAY 20TH APRIL, 2023 TIME: 12.00-2.00P.M

INSTRUCTION

- Answer question ONE and ANY OTHER TWO questions.

QUESTION ONE- COMPULSORY (30 Marks)

a. List any two types of errors **(2 marks)**

b. Evaluate $(\Delta+\nabla)^2(x^2+1)$ given that the interval of differencing is 4 **(5 marks)**

c. Find the binary form of $(17.859375)_{10}$ **(5 Marks)**

d. Find the sixth term of the sequence below using the forward difference table **(4 marks)**

$8, 12, 19, 29, 42$ **(6 Marks)**

e. Solve the system below by Cramer's method

$$x+2y+z=3$$
$$2x+3y+3z=10$$
$$3x-y+2z=13$$

f. Find the approximate root of $x^2-2x-3=0$ using the fixed point iteration method. Let $x_0=1$ and find x_4 **(6 Marks)**

g. Using linear interpolation formula for the given coordinates $(1,2)$ *and* $(4,5)$ find the values of y when $x=2$. **(2 Marks)**

Attempt **ANY TWO** Questions

QUESTION TWO (20 Marks)

a. Solve the system below by Crout's decomposition method **(7 Marks)**

$$x+y+z=1$$
$$4x+3y-z=6$$
$$3x+5y+3z=4$$

b. Find the Lagrange interpolation polynomial to fit the following data **(6 Marks)**

x	0	1	2	3
e^x-1	0	1.7183	6.3891	19.0855

Hence evaluate the value of $e^{1.5}$

c. Find a straight line to the data given below by the method of least squares approximation. Use it to estimate the value of y at x=2.5 **(5 Marks)**

x	0	1	2	3	4
y	1	1.8	3.3	4.5	6.3

d. Prove that $E=1+\Delta$ **(2 Marks)**

QUESTION THREE (20 Marks)

a. Consider the system of equations below

$$4x - y + z = 7$$
$$4x - 8y + z = -21$$
$$-2x + y + 5z = 15$$

Apply 4 times the Gauss Seidel iterative scheme to obtain the approximate solution to the system above. Assume the initial values to be $x_0 = 1, y_0 = 2, z_0 = 2$ **(7 Marks)**

b. Use Newton iteration formula $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$ to find the root of $x^3 - 2x + 1 = 0$. Take $x_0 = 0.5$ and find up to x_5. **(7 Marks)**

c. Solve the system below using Doolittle method **(6 Marks)**

$$16x - 4y + 4z = 24$$
$$-4x + 5y + 3z = -6$$
$$4x + 3y + 14z = 15$$

QUESTION FOUR (20 Marks)

a. Evaluate $\int_0^{\pi} \sin x dx$ by the Simpson's rule. Compare your result with analytical result **(7 Marks)**

b. Using linear interpolation formula, find the equation for the coordinates (6, 8) and (10, 16). What is the value of y when x=5? **(3 Marks)**

c. Use backward differences to find y_{-1} if $y_0 = 2, y_1 = 9, y_2 = 28, y_3 = 65, y_4 = 126$ and $y_5 = 217$ **(4 marks)**

d. Use Romberg's method to evaluate $\int_0^1 \frac{1}{1+x^2} dx$. Let $h_1 = 0.25$ and $h_2 = 0.125$ **(6 Marks)**

QUESTION FIVE (20 Marks)

a. Find the first two derivatives of $x^{\frac{1}{3}}$ at $x=50$ and $x=56$ given the table below (8 Marks)

x	50	51	52	53	54	55	56
$y=x^{\frac{1}{3}}$	3.6840	3.7084	3.7325	3.7563	3.7798	3.803	3.82259

b. Set up the fixed point iteration scheme for finding the root of $x\tan x=0.5$ which lies between 0.6 and 0.7 Test for stability. (6 Marks)

c. Compute y at $x=0.25$ by the modified Euler method given that $y'=2xy$ and $y(0)=1$. Let $h=0.125$ (6 Marks)