National University of Computer and Emerging Sciences

Basic Mechanical Engineering (ME2001)

Date: February 29, 2024

Course Instructor(s)

1. Dr. Kashif Saeed
2. Mohsin Yousuf (CM)

Sessional-I Exam

Total Time: 1 Hour
Total Marks: 40
Total Questions: **02**
Total Pages: 04
Semester: SP-2024
Campus: Lahore
Dept: Electrical Engineering

Student Name	Roll No	Section	Student Signature

Vetted by	Vetter Signature

Instruction/Notes:

1. It's a **closed book**, **closed notes** exam.
2. Attempt all questions, programmable calculators are not allowed.
3. The exam is to be solved on the question paper.
4. Your answers should be correct up to three **(3) decimals** with proper **SI units**.
5. Efficiently use the space provided (**No Additional Sheets allowed**).
6. State your answers clearly and with the help of diagrams, where necessary.

40

Problems ↓	Assessment of CLOs										Part (a)	Part (b)	Total Score
	CLO # 1					CLO # 1							
	E 5	P 4	D 3	B 2	N 1	E 5	P 4	D 3	B 2	N 1			
1											/ 10	/ 10	/ 20
2											/ 10	/ 10	/ 20

National University of Computer and Emerging Sciences

CLO # 01: Calculate the moment of a force/couple ***(C2)***

Q1: For the structure built in at point O as shown in the Figure 1, it supports $300\ N$ and $400\ N$ couples. **[20 marks]**

Determine the resultant couple moment vector, using both **(a)** scalar and **(b)** vector approaches.

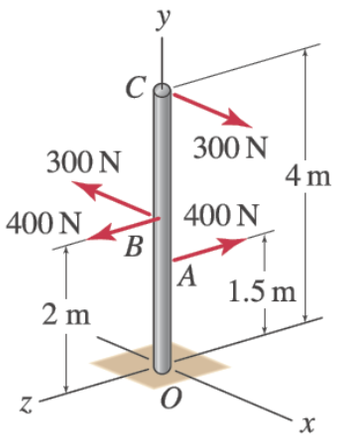

Figure 1. Structure built in at point O

VECTOR

$$\vec{M}_1 = \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} \times \begin{bmatrix} 300 \\ 0 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 \\ 0 \\ -600 \end{bmatrix} N.m$$

$$\vec{M}_2 = \begin{bmatrix} 0 \\ 0.5 \\ 0 \end{bmatrix} \times \begin{bmatrix} 0 \\ 0 \\ 400 \end{bmatrix}$$

$$= \begin{bmatrix} 200 \\ 0 \\ 0 \end{bmatrix} N.m$$

$$\vec{M}_R = \begin{bmatrix} 200 \\ 0 \\ -600 \end{bmatrix} N.m$$

SCALER

$M_1 = (300)(2) = 600\ Nm$ $-z$

$M_2 = (400)(0.5) = 200\ Nm$ $+x$

Moments cannot be added if they are in different directions.

CLO # 01: Calculate the moment of a force/couple ***(C2)***

Q2: For the diagram shown in Figure 2, **determine** the moment of the force F about line AB as follows. **[20 marks]**

(a) Determine the moment of F about point A, $\boldsymbol{M}_A$, and then the component of this moment in the direction of line AB.

(b) Determine the moment of F about point B, $\boldsymbol{M}_B$, and then the component of this moment in the direction of line AB.

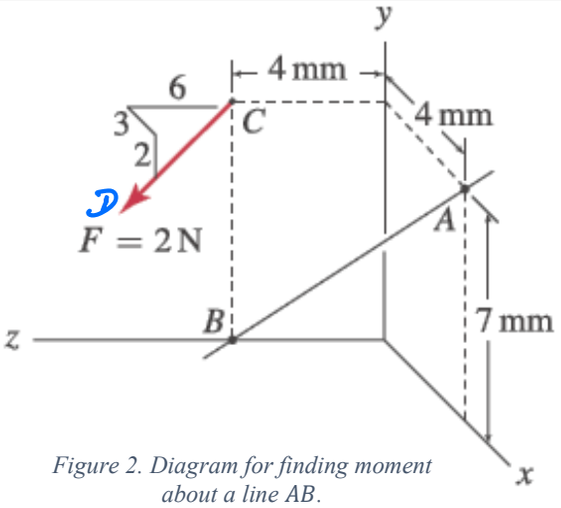

Figure 2. Diagram for finding moment about a line AB.

Also, **comment** on differences and/or agreement between the two computations.

DIRECTION of $\vec{F}$

$$\vec{CD} = \begin{bmatrix} 3 \\ -2 \\ 6 \end{bmatrix}$$

$$|\vec{CD}| = \sqrt{3^2 + 2^2 + 6^2} = \sqrt{49} = 7$$

$$\hat{CD} = \begin{bmatrix} 3/7 \\ -2/7 \\ 6/7 \end{bmatrix}$$

$$\vec{AB} = \begin{bmatrix} -4 \\ -7 \\ 4 \end{bmatrix} \text{ mm}$$

$$\hat{AB} = \begin{bmatrix} -4/9 \\ -7/9 \\ 4/9 \end{bmatrix}$$

$$\vec{F} = \begin{bmatrix} 6/7 \\ -4/7 \\ 12/7 \end{bmatrix} \text{ N}$$

MOMENT ABOUT A

$$\vec{AC} = \begin{bmatrix} -4 \\ 0 \\ 4 \end{bmatrix} \text{ mm}$$

$$\vec{M}_A = \begin{bmatrix} -4 \\ 0 \\ 4 \end{bmatrix} \times \begin{bmatrix} 6/7 \\ -4/7 \\ 12/7 \end{bmatrix} = \begin{bmatrix} 2.286 \\ 10.286 \\ 2.286 \end{bmatrix} \text{ N.mm}$$

Component Of $\vec{M}_A$ Along AB

$$\vec{M}_A \cdot \hat{AB} = \begin{bmatrix} 2.286 \\ 10.286 \\ 2.286 \end{bmatrix} \cdot \begin{bmatrix} -4/9 \\ -7/9 \\ 4/9 \end{bmatrix} = -8.0 \text{ N.mm}$$

Moment About B

$$\vec{BC} = \begin{bmatrix} 0 \\ 7 \\ 0 \end{bmatrix} \text{ mm}$$

$$\vec{M}_B = \begin{bmatrix} 0 \\ 7 \\ 0 \end{bmatrix} \times \begin{bmatrix} 6/7 \\ -4/7 \\ 12/7 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \\ -6 \end{bmatrix} \text{ N.mm}$$

$$\vec{M}_B \cdot \hat{AB} = \begin{bmatrix} 12 \\ 0 \\ -6 \end{bmatrix} \cdot \begin{bmatrix} -4/9 \\ -7/9 \\ 4/9 \end{bmatrix} = -8.0 \text{ N.mm}$$