



FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF MINING ENGINEERING

ENGINEERING MECHANICS

EMM 1103 / EMG 1103

Final Examination Paper

September 2023

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Mr. K. Garapo

INSTRUCTIONS

1. Answer all questions in Section A and any three questions from Section B.
2. Begin each solution for a new question on a new page and show all working.
3. Section A consists of a **four** question carrying **10 marks** each.
4. Section B consists of **four** questions carrying **20 marks** each.
5. Use of calculators is permissible.

Additional Requirements

None

MARK ALLOCATION

Questions	Marks
Question 1	10
Question 2	10
Question 3	10
Question 4	10
Question 5	20
Question 6	20
Question 7	20
Question 8	20
Total Attainable	100

SECTION A (40 Marks): Answer all questions

Question 1

- a) State Newton's laws of motion. [6]
- b) Explain Newton's third law of motion. [2]
- c) State Newton's law of gravitational attraction. [2]

Question 2

Draw diagrams to illustrate the following structures and structural elements: a) *continuous beam*, b) *simple truss*, c) *overhanging beam*, d) *cantilever beam*, e) *simply-supported beam*. [10]

Question 3

Given a cantilever beam of mass 40 kg, shown in Figure A3, sketch a free body diagram showing all the forces and moments acting on the beam, given that the system is in equilibrium. [10]

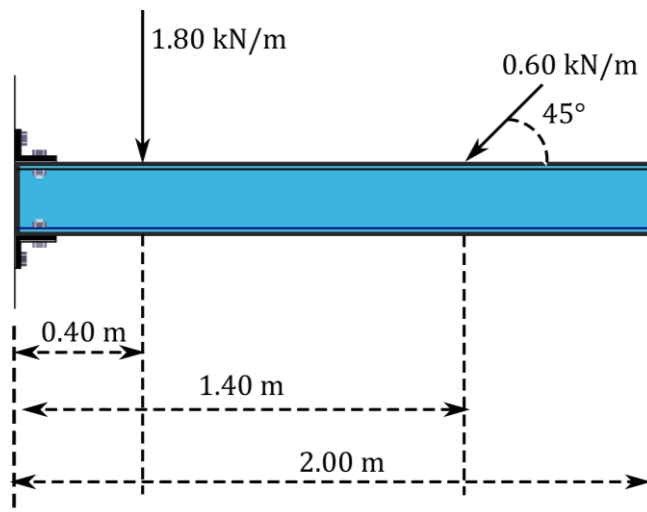


Figure A3: Cantilever beam

Question 4

Given a displacement vector $\vec{r}(t) = 3t^2\hat{i} + 4t^3\hat{j}$, where t is time, determine the a) *displacement*, b) *velocity* and c) *acceleration* at a time $t = 2s$. [10]

SECTION B (60 Marks): Answer any three questions

Question 5

- a) State the principle of transmissibility. [4]
- b) Determine resultant \vec{R} at point O of the three forces acting at points O, A and B on a rigid body as shown in Figure B1. [10]
- c) Determine the force-couple system at point B, given that point B is 0.25 m from point O [6]

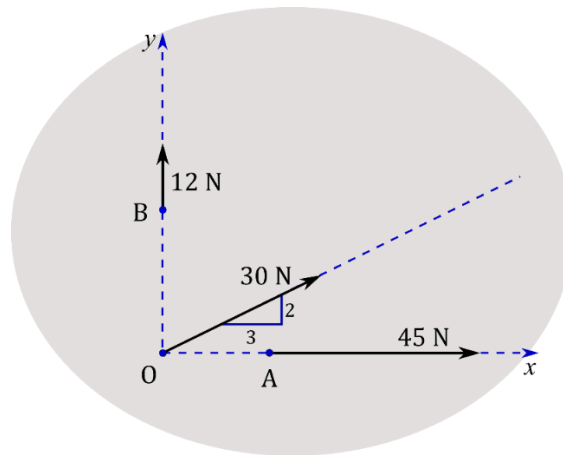


Figure B1: Three forces acting on a rigid body at points O, A and B

Question 6

A granular material exerts distributed loading on a beam as shown in Figure B2. Determine the magnitude and location of the equivalent resultant of this load. [20]

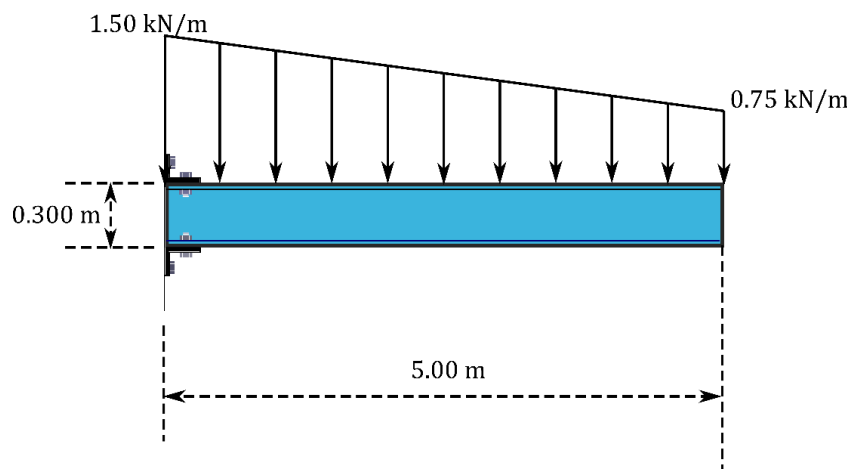


Figure B2: Distributed loading on a beam

Question 7

Refer to Figure B3, which shows three forces acting on an eye bolt, to answer the following questions:

- Outline Varignon's principle, with the aid of an appropriate diagram. [5]
- Determine the displacement \vec{r} , of the centre of the bolt eye from point A. [5]
- Determine the moment \vec{M} due to the three forces about point A. Give your answer as a vector with appropriate units of measurement. [10]

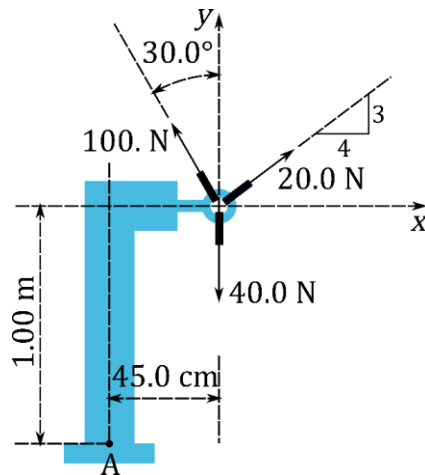


Figure B3: Three forces acting on eye bolt

Question 8

The right-angle bar shown in figure B4 rotates clockwise with an angular velocity which is decreasing at the rate of 4 rad/s^2 . Determine the vector expressions for the velocity and acceleration of point A when angular speed $\omega = 2 \text{ rad/s}$. [20]

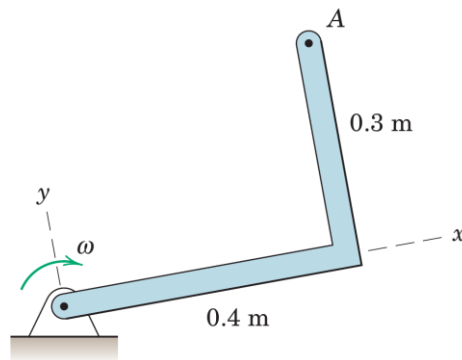


Figure B4: Rotating angle bar