Statics SKMM1203

Force couple system

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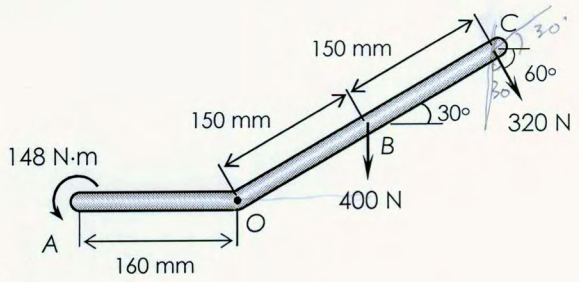
EXAMPLE

Rigid body *AOBC* is acted upon by the forces and couple as shown. Replace the system with an equivalent force–couple system at point O.



$\zeta \sum M = 148 - 400 \times 0.15\cos 30 - 320 \times 0.3$

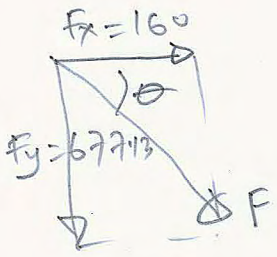
$= 0.04 \text{ Nm}$

$\simeq 0 \text{ Nm}$

$\pm \sum F_x = 320\cos 60 = 160 \text{ N}$

$+\uparrow \sum F_y = -400 - 320\sin 60$

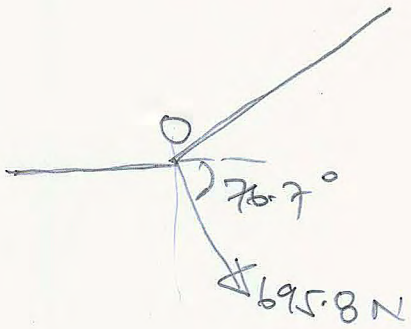
$= -677.13 \text{ N}.$



$F = 695.8 \text{ N}$

$\theta = 76.7°$

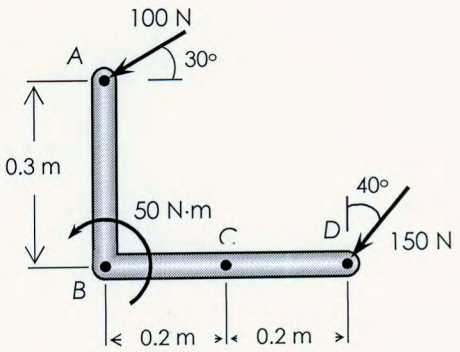
$\equiv$



EXAMPLE

Replace the system of forces and couple shown with an equivalent force–couple system at C.

(R = 246.3 N 42° ↙, M_C = 63 N·m ↺)



$\curvearrowleft \sum M_C = 50 + 100 \sin 30 \times 0.2 + 150 \cos 30 \times 0.3 - 150 \cos 40 \times 0.2$

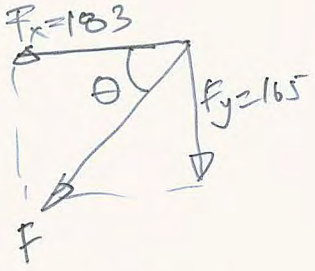
$= 63 \text{ N·m } \curvearrowleft$

$\pm \sum F_x = -100 \cos 30 - 150 \sin 40$

$= -183 \text{ N}$

$+\uparrow \sum F_y = -100 \sin 30 - 150 \cos 40$

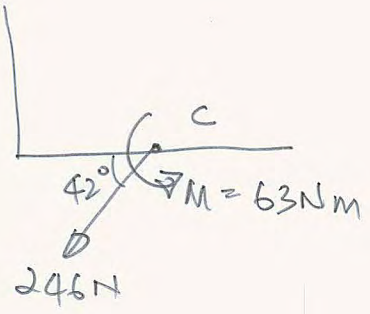
$= -165 \text{ N}$



$F = 246 \text{ N}$

$\theta = 42°$

=



UNIVERSITI TEKNOLOGI MALAYSIA

FAKULTI KEJURUTERAAN MEKANIKAL

TEST 2 | SME1203 | STATICS | SEM I | SESSION 2010/2011

QUESTION 1

Replace the system of forces and couple acting on the rigid body (as listed in **Table 1**) with an equivalent force–couple system at *B*.

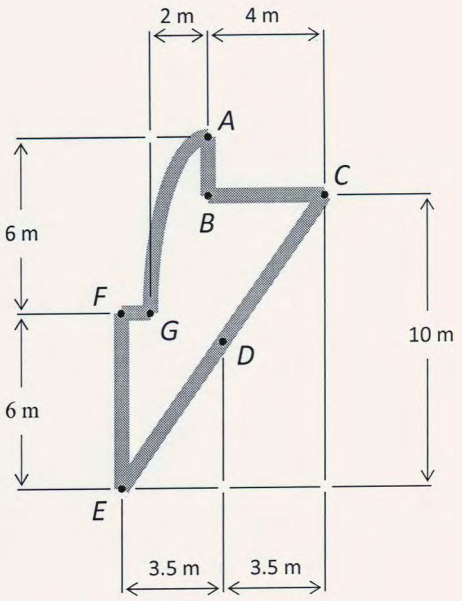


Table 1 (Jadual 1)

Point *A* $F_A = -5$ kN **j**

Point *B* $F_B = 8$ kN 30°

Point *C* $F_C = 6.5$ kN (12, 5)

Point *D* $M_D = 2$ kN·m **k**

Point *E* $M_E = -9$ kN·m **k**

Point *F* $F_E = 5$ kN **i**

Point *G* $F_G = -3$ kN **i** + 4 kN **j**

SOALAN 1

Gantikan sistem daya dan gandingan yang bertindak ke atas badan tegar (seperti tersenarai dalam **Jadual 1**) dengan satu sistem daya–gandingan setara di *B*.

SOLUTIONS (PENYELESAIAN)

$(+\rightarrow)\ \Sigma F_x = R_x$

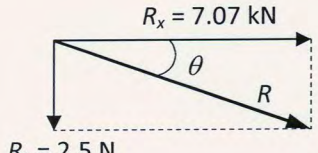
$R_x = -8\cos 30° + 6.5\left(\frac{12}{13}\right) + 5 - 3$

$= -6.93 + 6 + 5 - 3 = 7.07$ kN $\rightarrow$

$(+\uparrow)\ \Sigma F_y = R_y$

$R_y = -5 - 8\sin 30° + 6.5\left(\frac{5}{13}\right) + 4$

$= -5 - 4 + 2.5 + 4 = -2.5$ kN $\downarrow$



$R = \sqrt{7.07^2 + 2.5^2} = 7.5$ kN

$\theta = \tan^{-1}\frac{2.5}{7.07} = 19.47°$

$(+\circlearrowright)\ \Sigma M_B = 6.5\left(\frac{5}{13}\right)(4) - 2 + 9 - 5(3) + 3(4) + 4(2)$

$= 10 - 2 + 9 - 15 + 12 + 8$

$= 22$ kN·m $\circlearrowright$

Name : _____

Matric no. : _____ Programme: SM__ Section : __

Lecturer : _____

Q1 Q2 Q3

ANSWER ALL 3 (THREE) QUESTIONS **1 HOUR**

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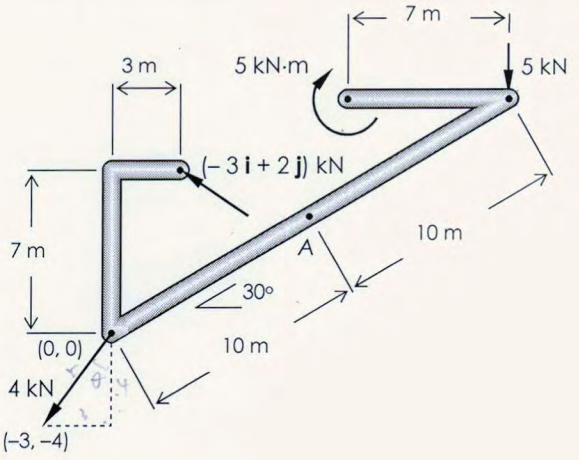
UNIVERSITI TEKNOLOGI MALAYSIA
FACULTY OF MECHANICAL ENGINEERING

TEST II | SME1203 | STATICS | SEM 1 | SESSION 2009/2010

QUESTION 1

Replace the system of forces and couple shown with an equivalent force–couple system at A.



SOALAN 1

Gantikan sistem daya dan gandingan dalam rajah kepada satu sistem daya–gandingan setara di A.

SOLUTION/ PENYELESAIAN

Determine Resultant

$(+\rightarrow)$ $\Sigma F_x = R_x$

$R_x = -4(3/5) - 3$

$= -5.4$ kN

$\therefore$ $R_x = 5.4$ kN $(\leftarrow)$

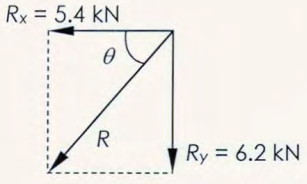
$(+\uparrow)$ $\Sigma F_y = R_y$

$R_y = -5 - 4(4/5) + 2$

$= -6.2$ kN

$\therefore$ $R_y = 6.2$ kN $(\downarrow)$

draw



$R = \sqrt{(5.4^2 + 6.2^2)} = 8.22$ kN

$\theta = \tan^{-1}(6.2/5.4) = 48.9°$

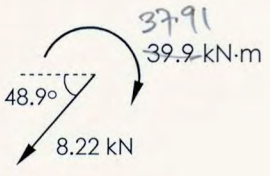
Determine Couple

$(+\circlearrowleft)$ $\Sigma M_A = 5 + 5(10 \cos 30°) - 4(4/5)(10 \cos 30°) + 4(3/5)(10 \sin 30°) - 3(7 - 10 \sin 30°) + 2(10 \cos 30° - 2)$

$= 5 + 43.3 - 27.7 + 12 - 6 + 13.32$

$M_A = 39.9$ kN·m

Equivalent Force–Couple system at A :



Q1 Q2 Q3

Name : _____

Matric no. : _____ Course : SM__ Section : ____

Lecturer : _____

ANSWER ALL 3 (THREE) QUESTIONS **1 HOUR**

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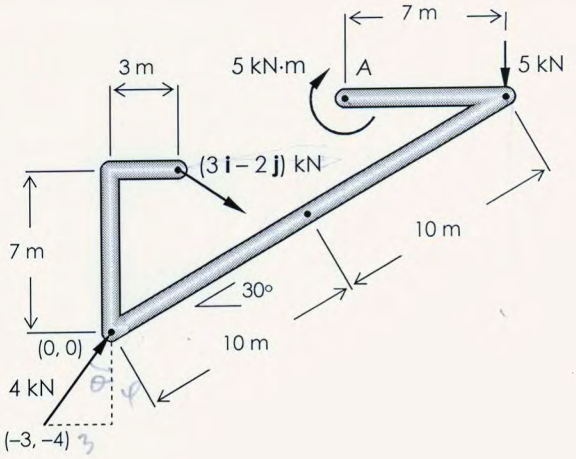
UNIVERSITI TEKNOLOGI MALAYSIA
FACULTY OF MECHANICAL ENGINEERING

TEST II | SME1203 | STATICS | SEM 1 | SESSION 2009/2010

QUESTION 1

Replace the system of forces and couple shown with an equivalent force–couple system at A.



SOALAN 1

Gantikan sistem daya dan gandingan dalam rajah kepada satu sistem daya–gandingan setara di A.

SOLUTION/ PENYELESAIAN

Determine Resultant

$(+\rightarrow)\quad \Sigma F_x = R_x$

$R_x = 4(3/5) + 3$

$= 5.4$ kN

$\therefore\quad R_x = 5.4$ kN $(\rightarrow)$

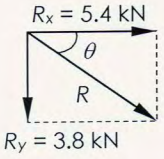
$(+\uparrow)\quad \Sigma F_y = R_y$

$R_y = -5 + 4(4/5) - 2$

$= -3.8$ kN

$\therefore\quad R_y = 3.8$ kN $(\downarrow)$

draw



$R = \sqrt{(5.4^2 + 3.8^2)} = 6.6$ kN

$\theta = \tan^{-1}(3.8/5.4) = 35.1°$

Determine Couple

$(+\circlearrowleft)\quad \Sigma M_A = 5 + 5(7)$

$+ 4(4/5)(20\cos 30°) - 4(3/5)(20\sin 30°)$

$- 3(10\sin 30°) - 2(20\cos 30° - 10)$

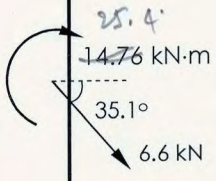
$= 5 + 12$

$- 55.4 + 24$

$- 15 + 14.64$

$M_A = -14.76$ kN·m

Equivalent Force–Couple system at A :



Name : _____

Matric no. : _____ Course : SM__ Section : ____

Lecturer : _____

ANSWER ALL 3 (THREE) QUESTIONS **1 HOUR**

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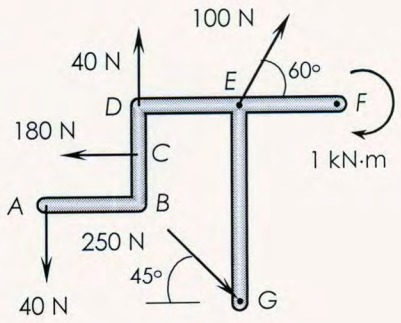
QUESTION 1

The rigid body *ABCDEF* is acted upon by forces and couples as shown in the diagram. Replace the system with an equivalent force-couple system at *E*.

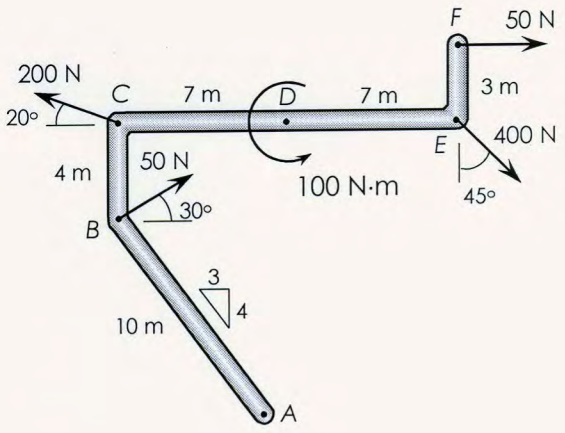
BC = *CD* = 1 m *DE* = *EF* = 2 m

EG = 4 m *AB* is not given



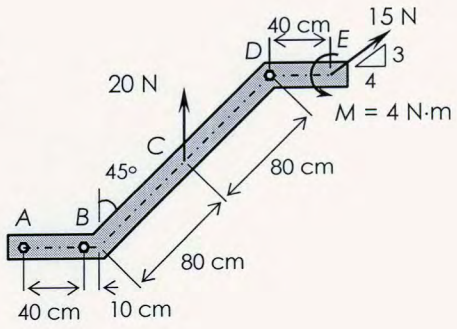
QUESTION 2

Replace the system of forces and couple in the figure with an equivalent force–couple system at *A*.



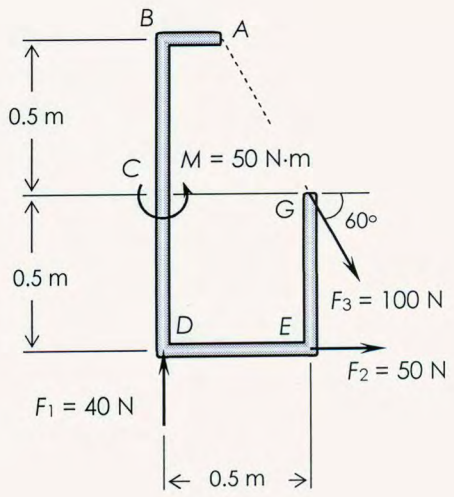
QUESTION 3

The figure shows a rigid body *ABCDE* acted upon by two forces and a couple. Determine an equivalent force-couple system at *A*.



QUESTION 4

Replace the system of forces and couples in the figure with an equivalent force–couple system at *B*.



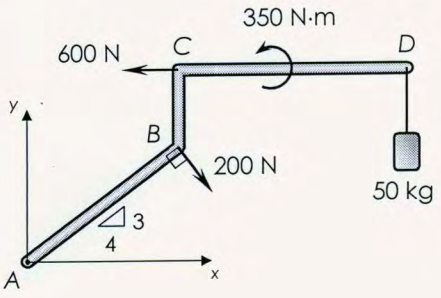
QUESTION 5

Replace the system of forces and couple in the figure with an equivalent force–couple system at *A*.

AB = 250 mm

BC = 100 mm

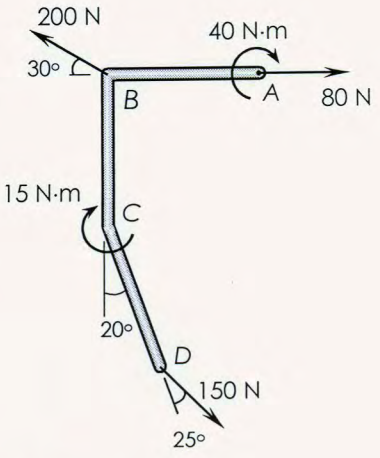
CD = 300 mm



QUESTION 6

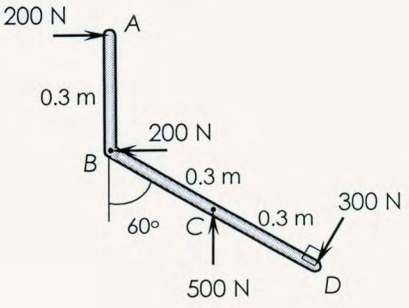
Replace the system of forces and couples in the figure with an equivalent force–couple system at *A*.

AB = *BC* = *CD* = 0.2 m



QUESTION 7

Replace the system of forces in the figure with an equivalent force–couple system at *B*.

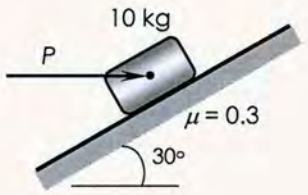


QUESTION

Determine the minimum force *P* required

a. to stop the block from sliding down the incline,

b. to start the block moving up the incline.

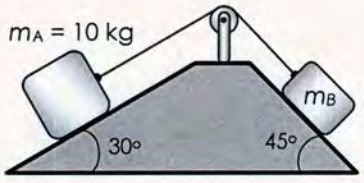


QUESTION

If the coefficient of static friction between all contacting surfaces $\mu_s = 0.3$, determine m_B when block *A* is on the verge of

a. moving up the incline plane.

b. moving down the incline plane.



QUESTION

Determine whether the 10 kg block is in equilibrium. Hence fine the friction force if

a. $m = 1.5$ kg.

b. $m = 5$ kg.