Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	STATICS
COURSE CODE	:	BNT 10303
PROGRAMME CODE	:	BNT
DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) Waste steel are loded by using magnetic cable crane as shown in **Figure Q1(a)**. The system is considered as equilibrium at *A*.

(i) How big net force at *A* (2 marks)

(ii) Describe the equilibrium force of the construction or ΣF (2 marks)

(iii) Write equilibrium in vector form (2 marks)

(b) The ball of steel *D* has a mass of 20 kg as shown in **Figure Q1(b)**. A force of F = 100 N is applied horizontally to the ring at *A*. It is known that the force in cable *AC* is zero.

(i) Write the equilibrium of the construction (3 marks)

(ii) Determine the angle θ (cable *AB*) (4 marks)

(iii) Determine the largest dimension (height) *d* (4 marks)

(c) A 20-kg flowerpot is supported with three cables (*AB*, *AC*, *AD*) as can be seen in **Figure Q1(c)**.

(i) Draw the Free Body Diagram at *A* (4 marks)

(ii) Determine the force of each cable needed to support the flowerpot (4 marks)

Q2 (a) Define the meaning of moment of couple and give **ONE (1)** example (2 marks)

(b) A manhole with 1 m diameter cover supported by a strut as shown in **Figure Q2(b)**. The strut exerts of 550 N of force between point *A* to *B*. The hinge of manhole cover located at the point *O*.

(i) Calculate position vector *A*, $\mathbf{r}_{OA}$ and *B*, $\mathbf{r}_{OB}$ (8 marks)

(ii) Determine Force Vector, F (7 marks)

(iii) Determine the moment of force F_{AB} about point *O*. (8 marks)

Q3 (a) A frame of L exert four external forces. The location of each acting force is stated in **Figure Q3(a)**. The forces act as in vertical and horizontal directions.

(i) Replace the loading on the frame by a single resultant force, F (5 marks)

(ii) Determine the angle θ (direction) (5 marks)

(iii) Specify the location of a single force along AB which is measured from A, d (5 marks)

(b) The man has a weight W and stands at the center of the plank. The planes at A and B are smooth as shown in **Figure Q3(b)**. There is tension along the cord.

(i) Draw the Free Body Diagram (2 marks)

(ii) Determine the tension, T in the cord in terms of W and θ (4 marks)

(iii) Determine the reaction at the support B, N_B in terms of W and θ (4 marks)

Q4 (a) The force created in the hydraulic cylinders EF and AD in order to hold the shovel in equilibrium. The shovel load has a mass of 1.25 Mg and a center of gravity at G. All joints are pin connected. The shovel can be seen in **Figure Q4(a)**.

(i) Draw a Free Body Diagram at the handle of bucket H (2 marks)

(ii) Draw a Free Body Diagram at bold C (4 marks)

(iii) Determine the force created in the hydraulic cylinders EF and AD (4 marks)

(b) The short steel bridge is constructed as in **Figure Q4(b)**. Two forces are implemented as 11 kN and 22 kN at B and C. It is known that the force developed in members FE, EB, and BC.

(i) Determine the reaction on D, N_D (4 marks)

(ii) Determine the force developed in FE, EB and BC (6 marks)

(iii) State if these members are in tension or compression (5 marks)

Q5 A concrete dam construction is shown in **Figure Q5**. The factor of safety for tipping of the concrete dam is defined as the ratio of the stabilizing moment due to the dam's weight divided by the overturning moment about O due to the water pressure. The concrete has a density of $\rho_{conc} = 2.5$ Mg/m^3 and for water $\rho_w = 1$ Mg/m^3.

(a) Determine the forces that act on the dam and their respective points of application (15 marks)

(b) Determine overturning moment and stabilizing moment about O (5 marks)

(c) Determine the factor of safety, F.S. (5 marks)

Q6 The uniform crate has a mass of 150 kg. The coefficient of static friction between the crate and the floor is $\mu_s = 0.2$. The coefficient of static friction between his shoes and the floor is $\mu_s' = 0.45$. The man exerts only a horizontal force on the crate as shown in **Figure Q6**.

(a) Draw a Free Body Diagram of the crate (5 marks)

(b) Draw a Free Body Diagram of the man (5 marks)

(c) Determine the smallest mass of the man m so he can move the crate. Assuming that the crate slips before tipping. (15 marks)

- END OF QUESTIONS –

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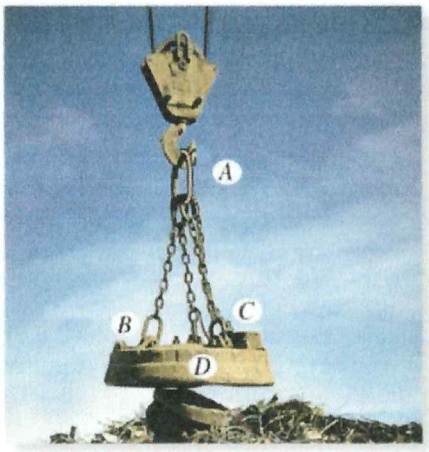

Figure Q1(a): Magnetic cable crane

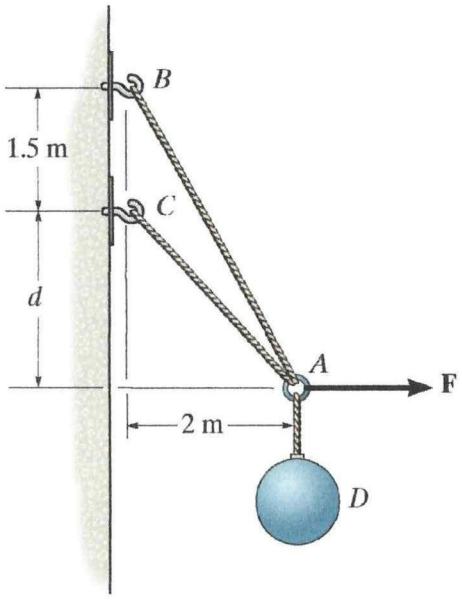

Figure Q1(b): Ball of steel

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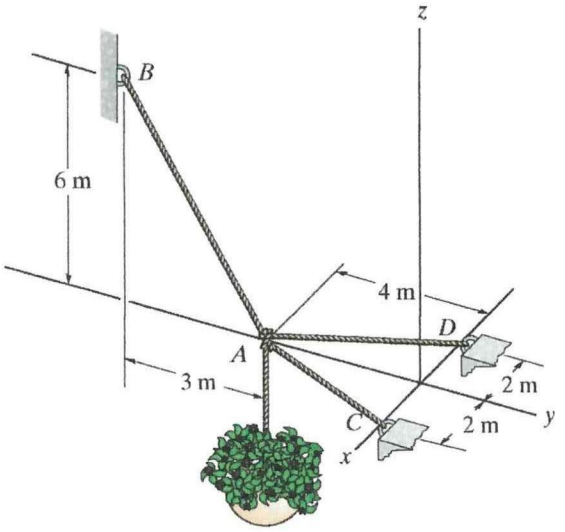

Figure Q1(c): Flowerpot with supported cables

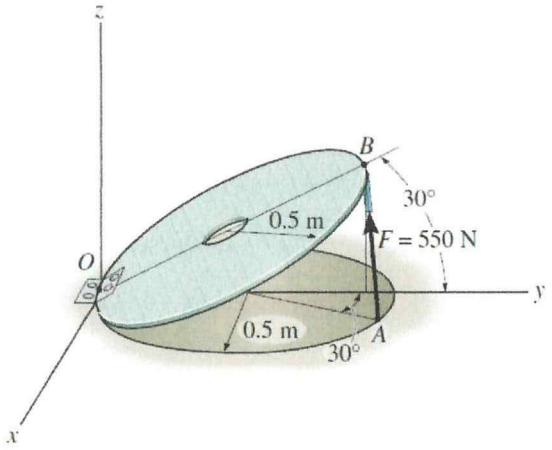

Figure Q2(b): Circular manhole

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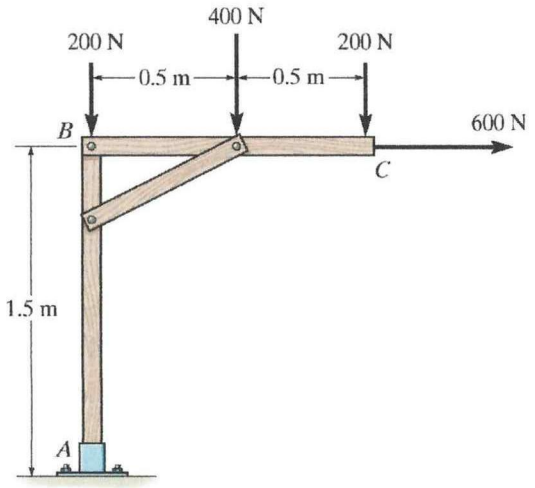

Figure Q3(a): L wood frame

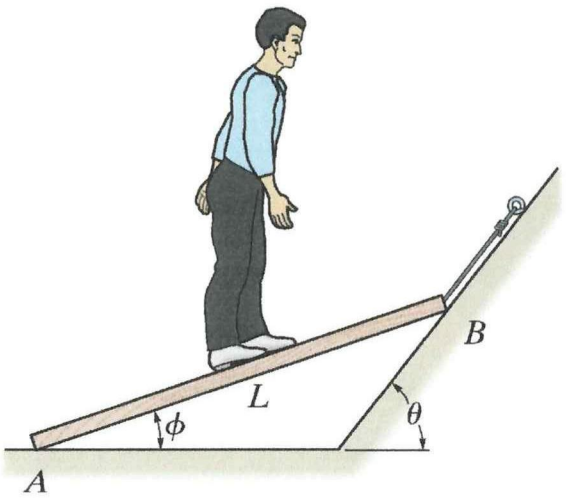

Figure Q3(b): Flat plank

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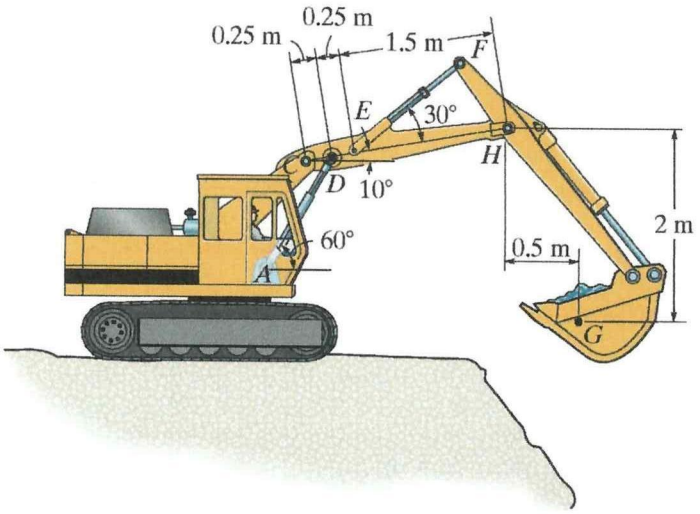

Figure Q4(a): Shovel with hydraulic cylinders

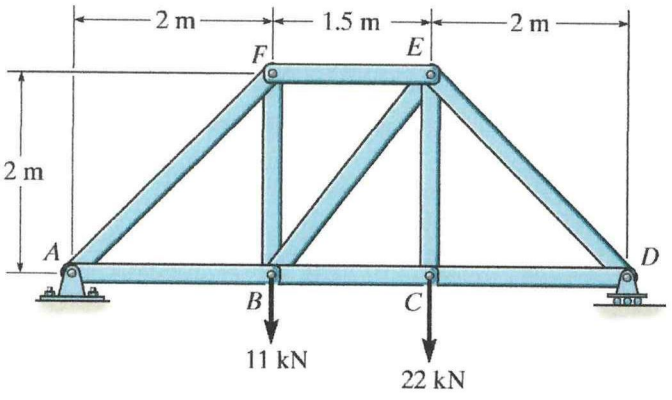

Figure Q4(b): Truss of small steel bridge

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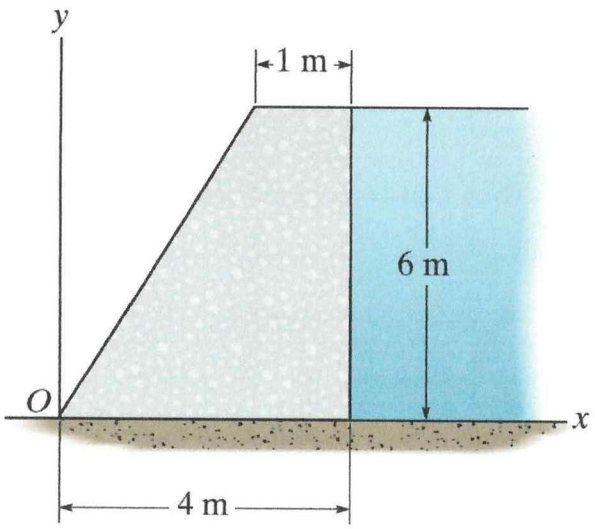

Figure Q5: Concrete dam

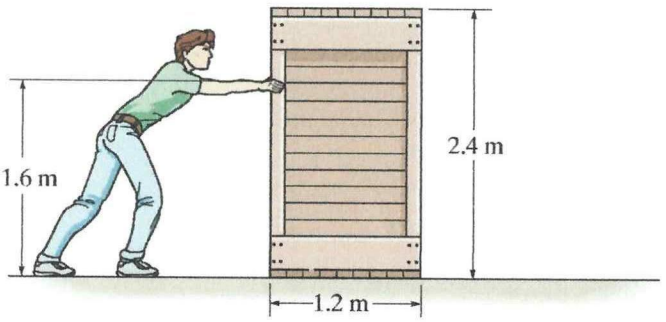

Figure Q6: Crate move along the floor

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FORMULA:

Cosine law:

$$C = \sqrt{A^2 + B^2 - 2AB\cos c}$$

Sine law :

$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

3 vectors:

$$\cos\alpha = \frac{A_x}{A}, \cos\beta = \frac{A_y}{A}, \cos\gamma = \frac{A_z}{A}$$

$$\mathbf{u}_A = \frac{\mathbf{A}}{A} = \frac{A_x}{A}\mathbf{i} + \frac{A_y}{A}\mathbf{j} + \frac{A_z}{A}\mathbf{k}$$

$$\mathbf{r}_{AB} - \{(X_B - X_A)\mathbf{i} + (Y_B - Y_A)\mathbf{j} + (Z_B - Z_A)\mathbf{k}\}$$

Moment:

$M_O = F\,d$
$M_O = r \times F$
$M_a = u_a \bullet M_O$

$$F_{Rx} = \sum F_x$$
$$F_{Ry} = \sum F_y$$
$$M_{Ro} = \sum M_c + \sum M_o$$