UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	STATICS
COURSE CODE	:	BNP 10102
PROGRAMME CODE	:	BNA/BNB/BNC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN PART A AND ANY **TWO (2)** QUESTIONS IN PART B

THIS QUESTION PAPER CONSISTS OF **THIRTEEN (13)** PAGES

PART A: Answer ALL Questions.

Q1 (a) Distinguish between centroid of lines and centroid of area. Write down the relevant equations too.

(5 marks)

(b) Using the method of composite curves, determine the centroidal coordinates of the line in **Figure PA-Q1(b)** that consists of the circular arc 1 and the straight lines 2 and 3.

(8 marks)

(c) Analyse and sketch the location of the centroid of the composite area by divided into 4 parts as shown in **Figure PA-Q1(c)**. All units are in mm.

(12 marks)

Q2 (a) Explain the moment of inertia and the application on civil engineering.

(5 marks)

(b) By using integration of $I_x = \int_A y^2 dA$. Determine the moment of inertia of the shaded area shown in **Figure PA-Q2(b)** about the x – axis.

(8 marks)

(c) Referring to the composite area shown in **Figure PA-Q2(c)**, analyse;

(i) The moment of inertia of the shaded area about the x and y axes.

(10 marks)

(ii) The radius of gyration of the composite areas.

(2 marks)

PART B: Answer TWO (2) Questions Only from Four Questions Provided.

Q1 (a) Define the moment of couple.

(2 marks)

(b) Discuss the concept of the moment of a force with aid of diagram. Write down the relevant equation too.

(5 marks)

(c) The hook is acted on by the three forces as shown in **Figure PB-Q1(c)**. Determine P and the angle θ, given that the resultant is 90 kN and be directed vertically upward.

(8 marks)

(d) Two couples act on the beam as shown in **Figure PB-Q1(d)**. If the resultant couple moment on the beam is to be zero, determine the required magnitude of force F.

(10 marks)

Q2 (a) Describe in which condition a rigid body is in equilibrium.

(2 marks)

(b) With the aid of diagrams, briefly explain **TWO (2)** types of supports and their reactions.

(5 marks)

(c) The bent beam ABC is attached to a pin at C and rest against a roller support at B as shown in **Figure PB-Q2(c)**. Neglecting the weight of the beam, find the reactions at B and C caused by the 150 kg load.

(8 marks)

(d) Analyse the reactions at supports A and B of the beam which is loaded as shown in **Figure PB-Q2(d)**. Neglecting the weight of the beam.

(10 marks)

Q3 (a) Define the term of equilibrium system.

(2 marks)

(b) With the aid of diagram, briefly explain **TWO (2)** categories of three dimensional force system.

(5 marks)

(c) Determine the force components acting at the roller A, on the ball and socket B, roller B and the tension on the cord CD as shown in **Figure PB-Q3(c)**.

(8 marks)

(d) Analyse the x , y , z components of reaction at the fixed wall A shown in **Figure PB-Q3(d)**. The 150-N force is parallel to the z axis and the 200 N force is parallel to the y axis.

(10 marks)

Q4 (a) Identify **TWO (2)** examples of friction occurring in real application.

(2 marks)

(b) Explain **TWO (2)** friction laws for dry surfaces on a horizontal surface, with the aid of diagrams. Write down the relevant equations too.

(5 marks)

(c) Find the weight W is necessary to start the system of blocks shown in **Figure PB-Q4(c)** moving to the right. The coefficient of friction under each block is 0.10 and the pulleys are assumed to be frictionless.

(8 marks)

(d) Referring to **Figure PB-Q4(d)**, analyse the range of mass m over which the system is in equilibrium if the pulley at B is free to rotate and the coefficient of static friction is 0.20 at shafts A and C.

(10 marks)

– END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS
PROGRAMME CODE : BNA/BNB/BNC
COURSE CODE : BNP 10102

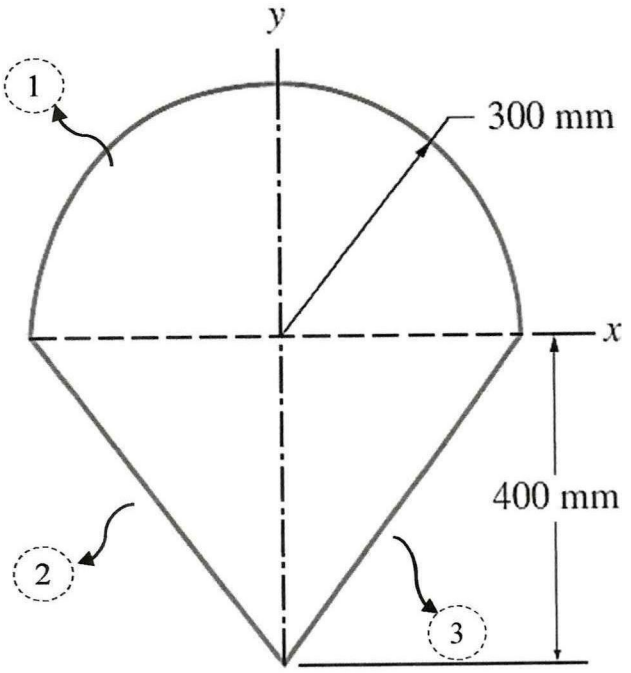

Figure PA-Q1(b)

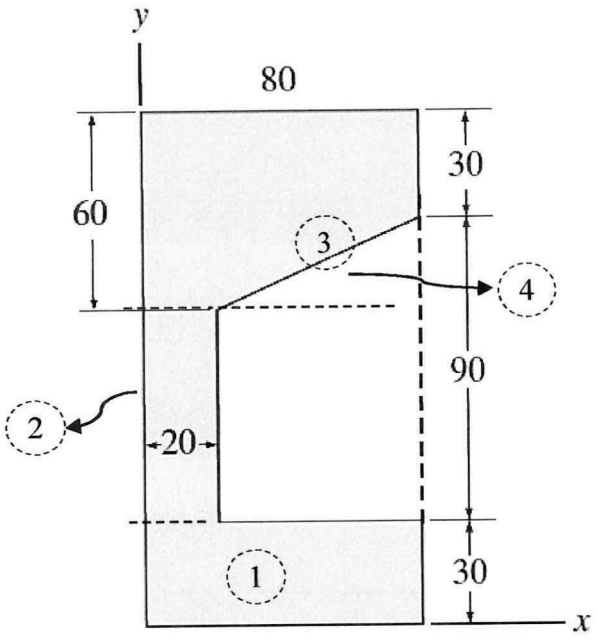

Figure PA-Q1(c)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS

PROGRAMME CODE : BNA/BNB/BNC
COURSE CODE : BNP 10102

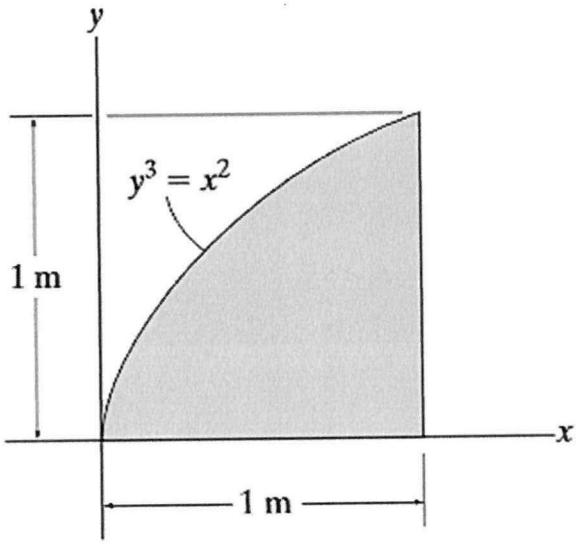

Figure PA-Q2(b)

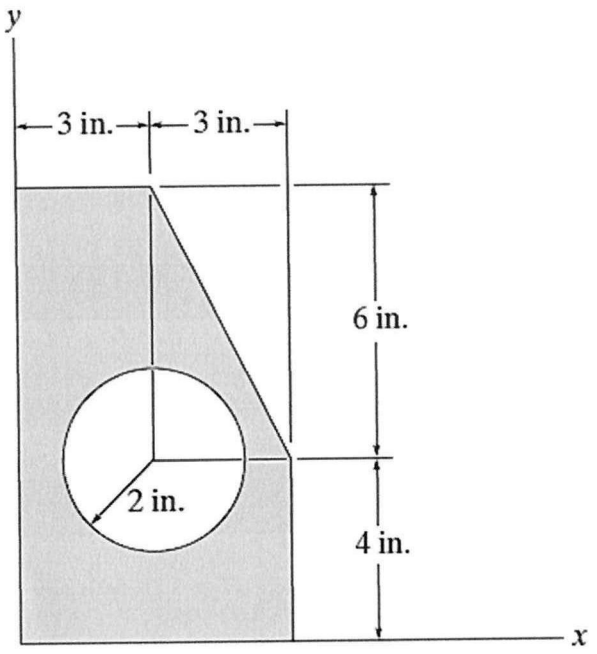

Figure PA-Q2(c)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS
PROGRAMME CODE : BNA/BNB/BNC
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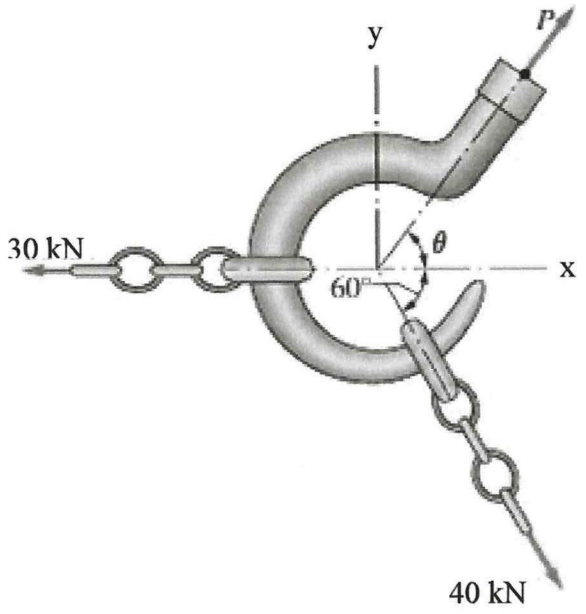

Figure PB-Q1(c)

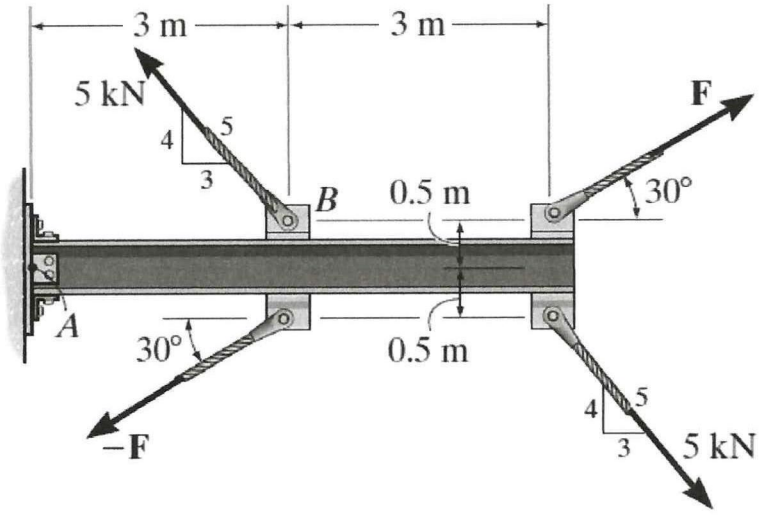

Figure PB-Q1(d)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS

PROGRAMME CODE : BNA/BNB/BNC
COURSE CODE : BNP 10102

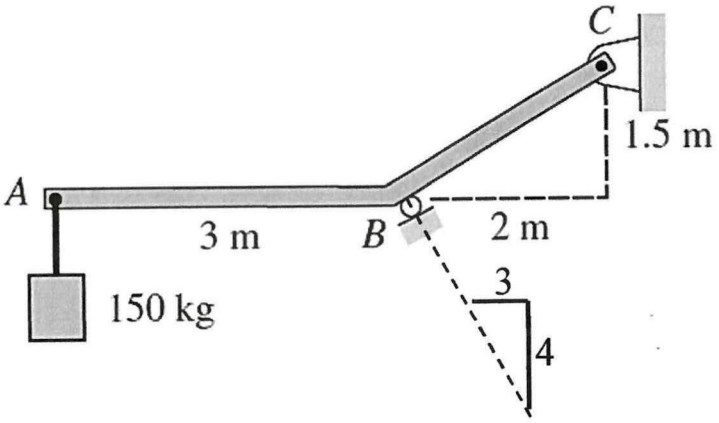

Figure PB-Q2(c)

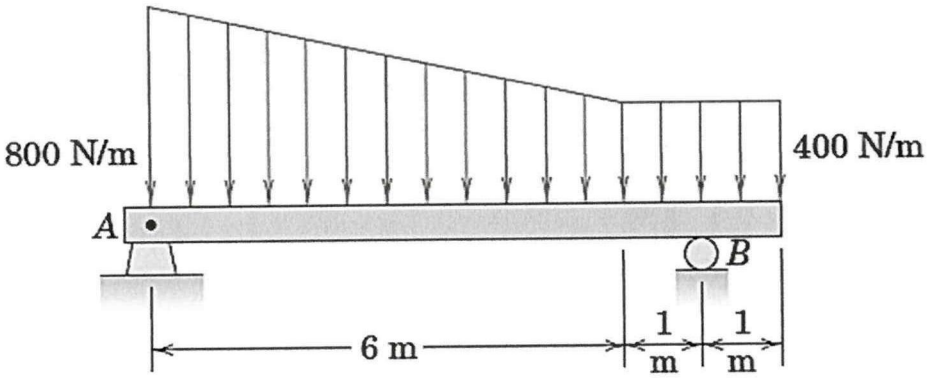

Figure PB-Q2(d)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS

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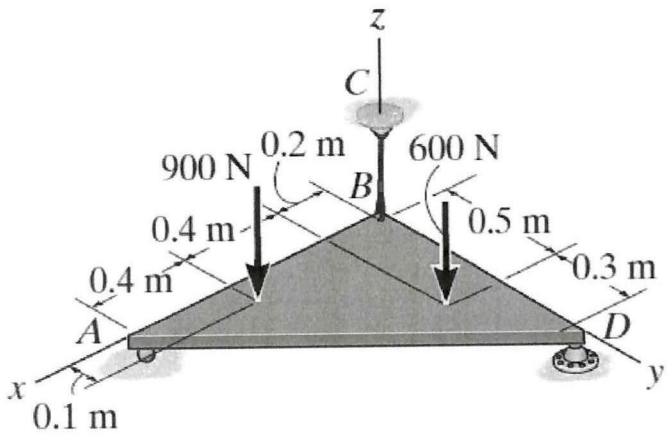

Figure PB-Q3(c)

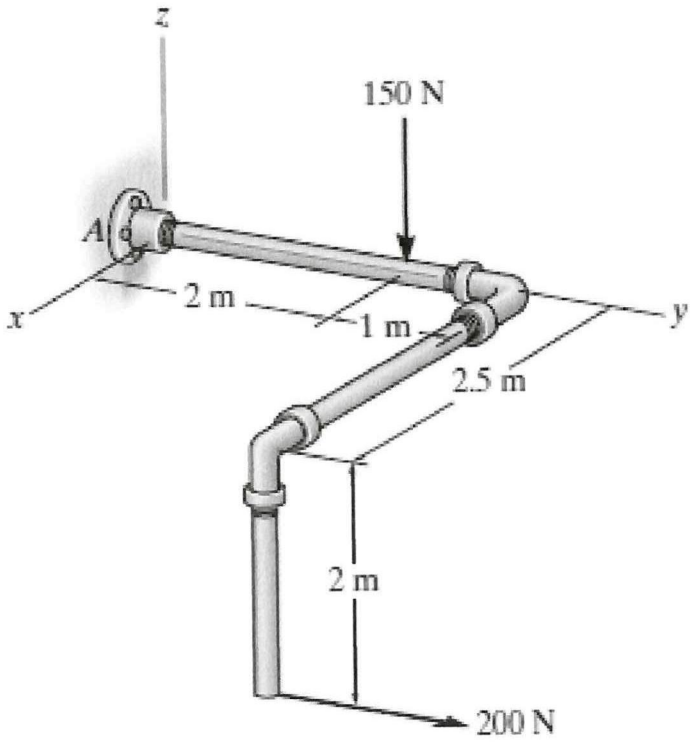

Figure PB-Q3(d)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS

PROGRAMME CODE : BNA/BNB/BNC
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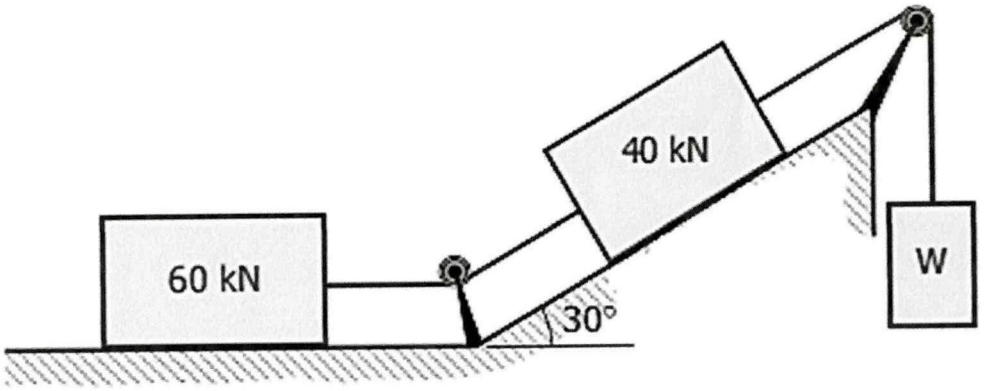


Figure PB-Q4(c)

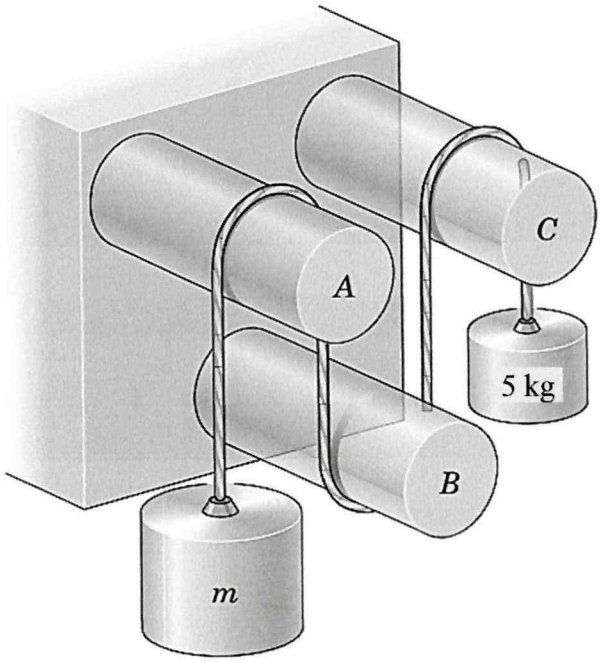


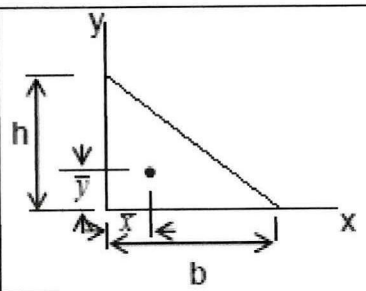
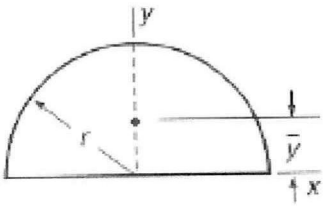
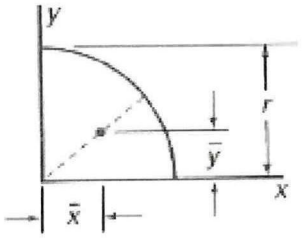
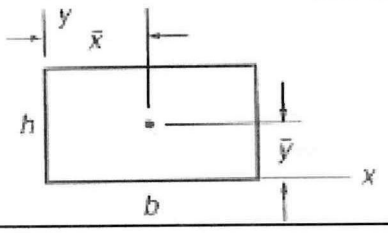
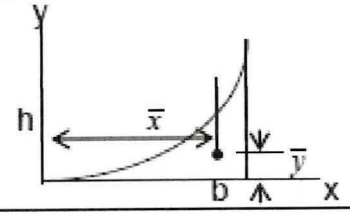
Figure PB-Q4(d)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS

PROGRAMME CODE : BNA/BNB/BNC
COURSE CODE : BNP 10102

Table 1: Centroid of Areas

Shape		$\bar{x}$	$\bar{y}$	A
Triangle		$\frac{b}{3}$	$\frac{h}{3}$	$\frac{1}{2}bh$
Semicircle		0	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{2}$
Quarter circle		$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{4}$
Rectangle		$\frac{b}{2}$	$\frac{h}{2}$	bh
Parabolic spanderl		$\frac{3b}{4}$	$\frac{3h}{10}$	$\frac{bh}{3}$

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : STATICS
PROGRAMME CODE : BNA/BNB/BNC
COURSE CODE : BNP 10102

Table 2: Centroid of Line

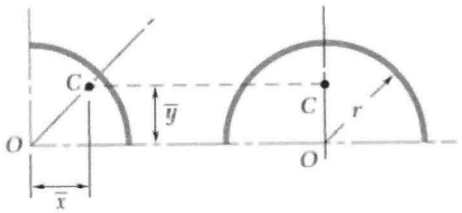
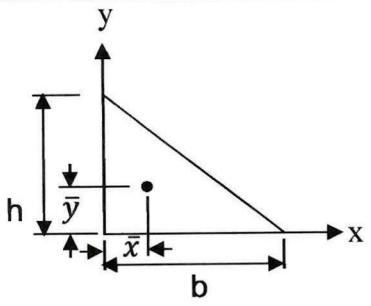
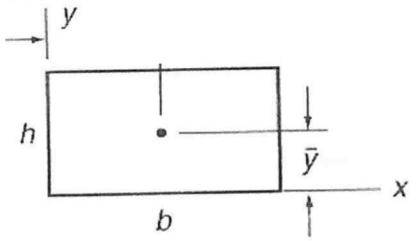
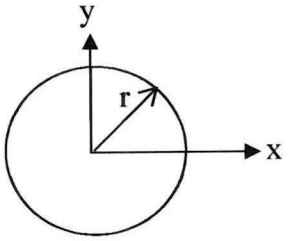
Shape		$\bar{x}$	$\bar{y}$	L
Quarter-circular arc		$\frac{2r}{\pi}$	$\frac{2r}{\pi}$	$\frac{\pi r}{2}$
Semicircular arc		0	$\frac{2r}{\pi}$	πr

Table 3: Moment of Inertia

Shape		Equation
Triangle		$I_x = \frac{bh^3}{36}, I_y = \frac{b^3h}{36}$
Rectangle		$I_x = \frac{bh^3}{12}, I_y = \frac{b^3h}{12}$ $J = \frac{1}{12}bh(b^2+h^2)$
Circle		$I_x = I_y = \frac{1}{4}\pi r^4$ $J = \frac{1}{2}\pi r^4$

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
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Equations:

$$F_R = \sqrt{(F_{Rx})^2 + (F_{Ry})^2}$$

$$\theta = \tan^{-1}\left(\frac{F_{Ry}}{F_{Rx}}\right)$$

$$\frac{A}{\sin\alpha} = \frac{B}{\sin\beta}$$

$$C^2 = A^2 + B^2 - 2AB\cos\gamma$$

$$\sin\theta = \frac{y}{r} = \frac{side\ \ opposite}{hypotenuse}$$

$$\cos\theta = \frac{x}{r} = \frac{side\ \ adjacent}{hypotenuse}$$

$$\tan\theta = \frac{y}{x} = \frac{side\ \ opposite}{side\ \ adjacent}$$

Belt friction;

$$\ln\frac{T_2}{T_2} = \mu_s\beta$$

$$\frac{T_2}{T_2} = e^{\mu_s\beta}$$

Maximum static friction force;
$F_s = F_{max} = \mu_s N = \mu_s (W)$

Kinetic friction force;
$F = \mu_k N = \mu_k (W)$

$F < F_s$ - block is not moving
$F = F_s$ - block is impending motion
$F > F_s$ - block is moving

Center of gravity

$$\bar{x} = \frac{\sum xL}{\sum L}, \qquad \bar{y} = \frac{\sum yL}{\sum L}$$

$$\bar{x} = \frac{\sum xA}{\sum A}, \qquad \bar{y} = \frac{\sum yA}{\sum A}$$

Moment of inertia

$$I_{xx} = I_x + Ad^2$$

$$I_{yy} = I_y + As^2$$

Radius of gyration:

$$\sum A = A_1 + A_2 + A_3$$

$$k_x = \sqrt{\frac{I_{xx}}{A}}, \quad k_y = \sqrt{\frac{I_{yy}}{A}}$$