UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *CIVIL ENGINEERING SCIENCE*
SUBJECT	:	**APPLIED MECHANICS 2A**
CODE	:	**MGACIA2 / MGA2A11**
DATE	:	WINTER EXAMINATION 30 MAY 2018
DURATION	:	(SESSION 2) 12:30 - 15:30
WEIGHT	:	50 : 50
TOTAL MARKS	:	100

ASSESSORS	:	MR P VAN TONDER MR T MAFOKOANE
MODERATOR	:	PROF S EKOLU
NUMBER OF PAGES	:	6 PAGES

INSTRUCTIONS	:	ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED. NO MOBILE PHONES OR PROGRAMMABLE CALCULATORS ALLOWED
REQUIREMENTS	:	NONE

INSTRUCTIONS TO STUDENTS

ANSWER SECTION A AND B IN SEPARATE EXAMINATION BOOKS AND HAND THE BOOKS IN SEPARATELY.
ALSO HAND IN THE QUESTION PAPER.

SECTION A – STATICS

QUESTION A1 [10]

a) Derive the Shear Stress Equation. (8.5)

$$\tau = \frac{VQ}{It}$$

b) What influences the shear stress that a structural member experiences? (1.5)

QUESTION A2 [10]

Draw the shear force and bending moment diagrams for the simple beam shown in Figure 1.

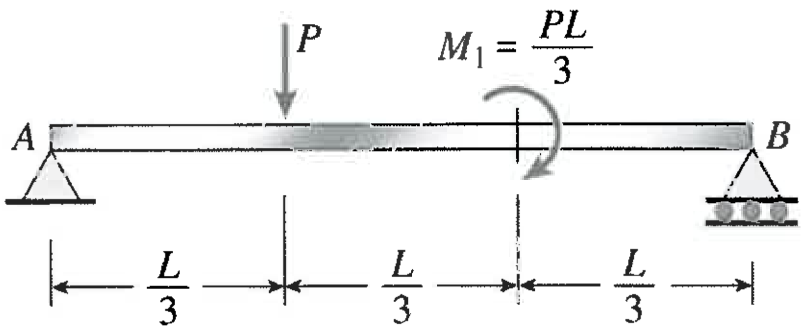

Figure 1

QUESTION A3 [4]

Determine the moment of inertia of the beam's cross-sectional area about the x-axis (Figure 2).

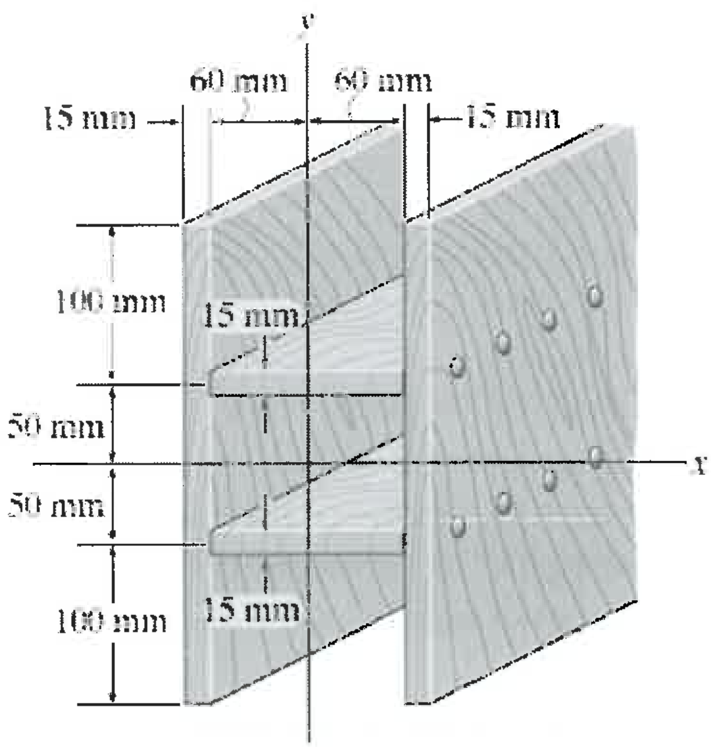

Figure 2

QUESTION A4 [10]

A 6 kN force is applied on the concrete stub column of negligible weight as shown in Figure 3. What is the area across which the point load can move without causing any uplift on the base?

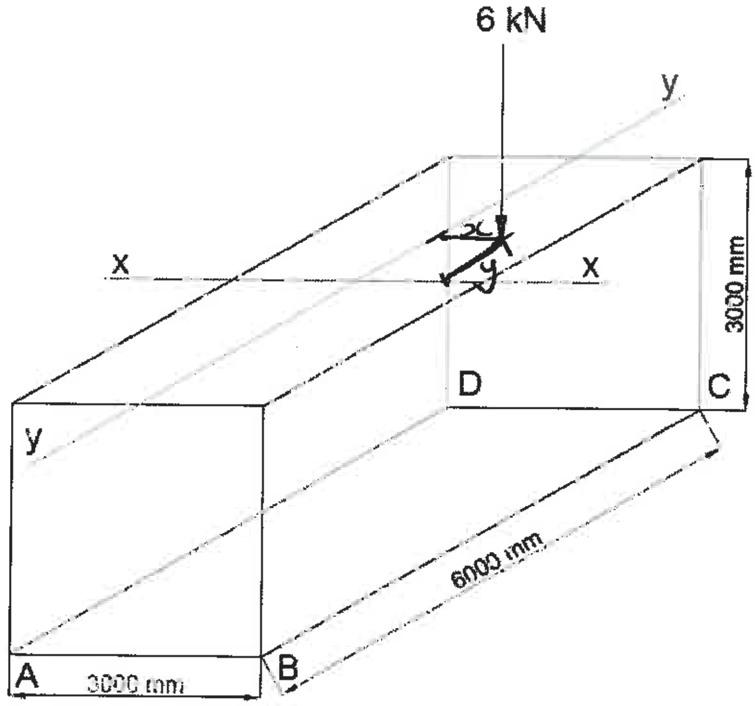

Figure 3

QUESTION A5 [16]

A simple beam *AB* supports a point load *P* acting at distances *a* and *b* from the left-hand and right-hand supports, respectively (Figure 4). Using a second order differential equations, determine:

a) The equations of the deflection curve.
b) The maximum deflection δ_{max} of the beam.

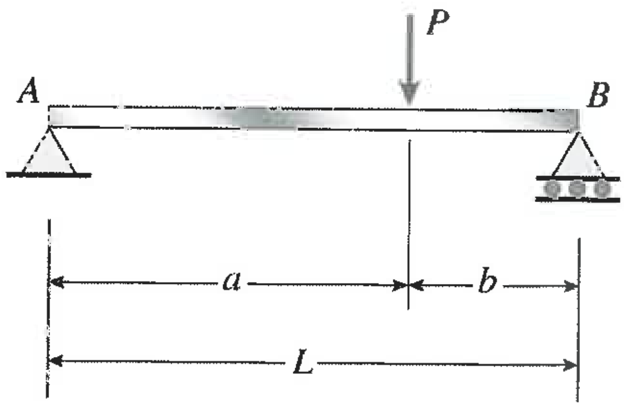

Figure 4

SECTION B – DYNAMICS

QUESTION B1 [14]

An open-belt drive connects two pulleys, 1.2 and 0.5 m diameter, on parallel shafts 3.6 m apart. The belt has a mass of 0.9 kg/m length, and the maximum tension in it is not to exceed 2 kN. The 1.2 m pulley, which is the driver, runs at 200 rev/min. Due to belt slip on one of the pulleys, the velocity of the driven shaft is only 450 rev/min. If $\mu = 0.3$, calculate:

a) The torque on each of the two shafts.
b) The power transmitted and the power lost in friction.
c) The efficiency of the drive.

QUESTION B2 [13]

A 45 kg piston is supported by a spring of modulus k = 35 kN/m. A dashpot of damping coefficient c = 1 250 N.s/m acts in parallel with the spring. A fluctuating pressure p = 4 000 sin 30t in Pa acts on the piston, whose top surface area is 50 (10^{-3}) m^2. Determine the steady-state displacement as a function of time and the maximum force transmitted to the base.

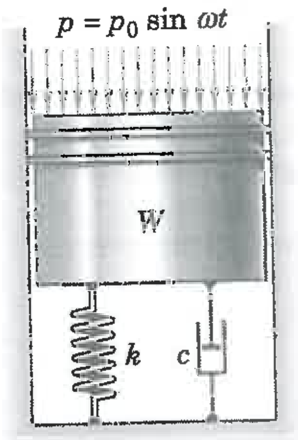

Figure 5

QUESTION B3 [13]

A spring-controlled centrifugal governor has two rotating masses. Each of mass 2.7 kg, and the limits of their radii of rotation are 100 mm and 125 mm. Each mass is directly controlled by a spring attached to it and to the casing of the governor. Figure 6. The stiffness of each spring is 7 kN/m and the force in each spring, when the masses are in their mid-position, is 350 N. In addition, there is an equivalent constant inward radial force $R = 70$ N acting on each mass, in order to allow for the dead weight of the mechanism. Neglecting friction,

a) Find the range of speed of the governor.
b) What would be the required force in each spring, when the masses are in their mid-position, for isochronism and what would then be the speed?

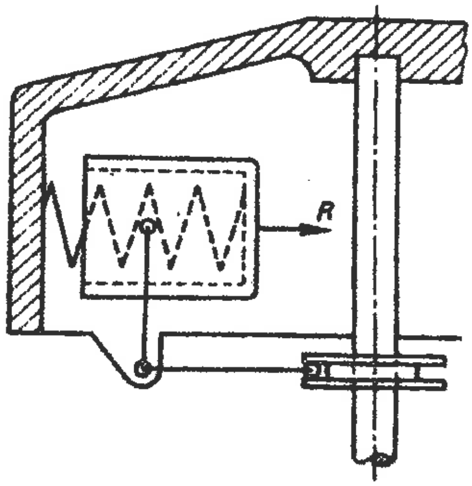

Figure 6

QUESTION B4 [10]

The open square frame in Figure 7 is constructed of four identical slender rods, each of length b. The small wheels roll without friction in the slots of the vertical surface. If the frame is released from rest in the position shown, determine the speed of corner A

a) after A has dropped a distance b and
b) after A has dropped a distance $2b$

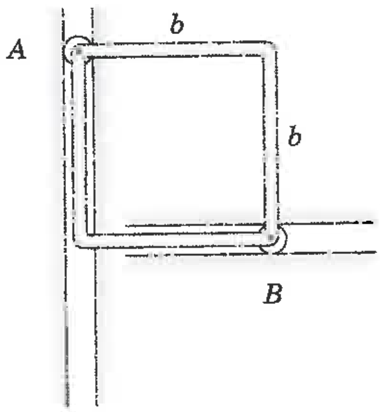

Figure 7

INFORMATION SHEET

$$X = \frac{F_0 / k}{\left\{\left[1-\left(\omega / \omega_n\right)^2\right]^2 + \left[2\delta\omega / \omega_n\right]^2\right\}^{1/2}}$$

$$\phi = \tan^{-1}\left[\frac{2\delta\omega / \omega_n}{1-\left(\omega / \omega_n\right)^2}\right]$$

$$\omega_n = \sqrt{k/m}$$

$$\varsigma = c / 2m\omega_n$$

$$M = \frac{1}{\left\{\left[1-\left(\omega / \omega_n\right)^2\right]^2 + \left[2\varsigma\omega / \omega_n\right]^2\right\}^{1/2}}$$

Mass moment of inertia of a rod = (1/12) m l^2

$$x_p = X\sin(\omega t - \phi)$$

$$Power = (T_1 - T_c)\left(1 - \frac{1}{e^{\mu\theta \cdot \mu\vartheta \operatorname{cosec}\beta}}\right)v$$

$$Power = (T_1 - T_2)v$$

$$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta \cdot \mu\vartheta \operatorname{cosec}\beta}$$

$$2T_0 = T_1 + T_2$$

$$x = A\cos(\omega_n t) + B\sin(\omega_n t)$$

$$T_c = mv^2$$

$$T_c = \frac{1}{3}T_1$$