UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *CIVIL ENGINEERING SCIENCE*
SUBJECT	:	**APPLIED MECHANICS 2A**
CODE	:	**MGACIA2 / MGA2A11**
DATE	:	SUPPLEMENTARY EXAMINATION JULY 2019
DURATION	:	3 Hours
WEIGHT	:	50 : 50
TOTAL MARKS	:	100

ASSESSORS	:	MR P VAN TONDER
MODERATOR	:	PROF S EKOLU
NUMBER OF PAGES	:	4 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 Flow Equation. (8.5)

$$f = \frac{VQ}{I}$$

b) Why do we need to design for shear flow within a structural member? (1.5)

QUESTION A2 [16]

Draw the shear force and bending moment diagram for beam *ABC* shown in Figure 1.

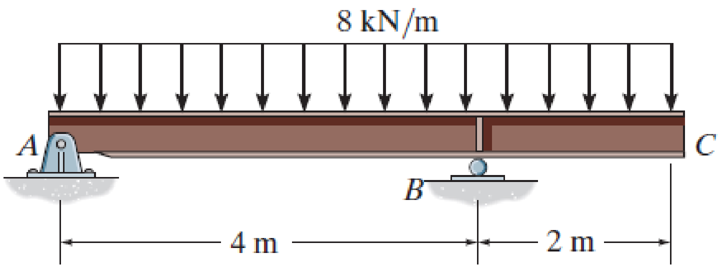

Figure 1

QUESTION A3 [14]

Determine the maximum deflection and rotation of the beam shown in Figure 2. Use a second order differential equation. EI is constant for the beam.

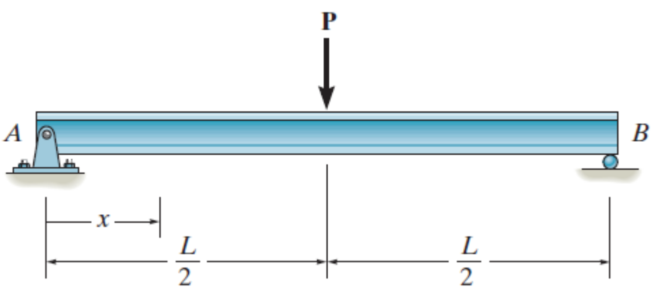

Figure 2

QUESTION A4 [10]

Repeat question A3, but using moment area theorems.

SECTION B – DYNAMICS

QUESTION B1 [15]

Three rotating masses, A = 14kg, B = 11kg and C = 21kg, are carried on a shaft, with centres of mass 275mm, 400mm and 150mm respectively from the shaft axis. The angular positions of B and C are 60° and 135° respectively from A, measured in the same direction. The distance between the planes of rotation A and B is 1.35m, and between those of A and C is 3.6m, B and C being on the same side of A.

Two balance masses are to be fitted, each with its centre of mass 225mm from the shaft axis, in the planes midway between those of A and B(take this mass as your reference plane) and of B and C. Determine the magnitude and angular position with respect to A of each balance mass.

<u>QUESTION B2</u> [9]

A steady 22N force is applied normal to the handle of the hand-operated grinder. The gear inside the housing with its shaft and attached handle have a combined mass of 1.8kg and a radius of gyration about their axis of 72mm. The grinding wheel with its attached shaft and pinion (inside housing) have a combined mass of 0.55kg and a radius of gyration of 54mm. If the gear ratio between gear and pinion is 4:1, calculate the speed N of the grinding wheel after 6 complete revolutions of the handle starting from rest.

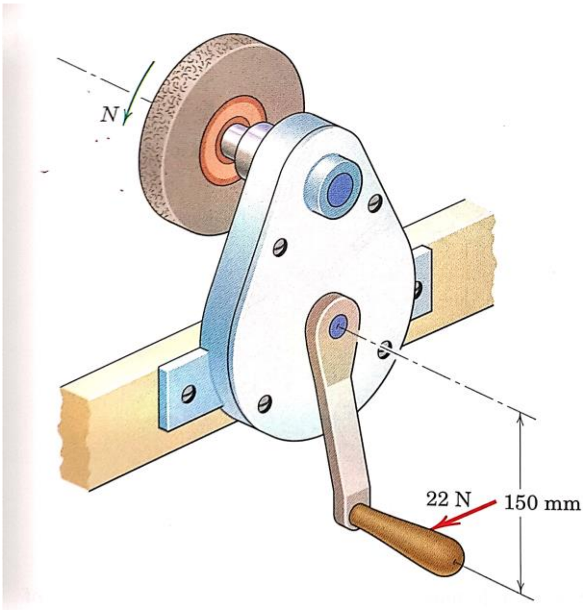

Figure 3

<u>QUESTION B3</u> [16]

In the mechanism shown in Figure 4, the link AB rotates with a uniform angular velocity of 30rad/s. Determine the velocity and acceleration of G for the configuration shown if C can only move horizontally.

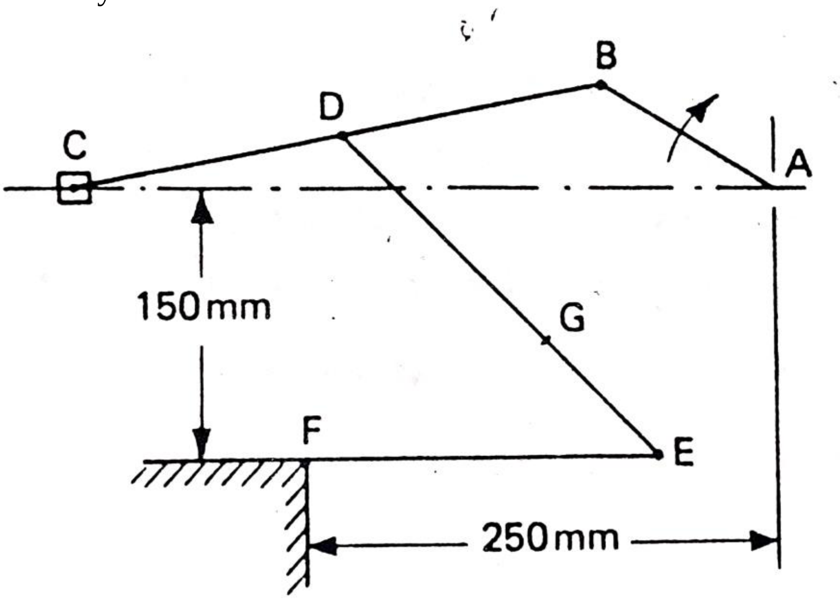

Figure 4

<u>QUESTION B4</u> [10]

Proof that the acceleration of a block sliding on a rotating link are:

- $\omega^2 r$ and $r\alpha \rightarrow$ radial and tangential accelerations of the coincident link point relative to O
- f and $2v\omega \rightarrow$ radial and tangential accelerations of the block relative to the coincident link point

<u>INFORMATION SHEET</u>

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

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

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

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

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

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

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