THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

MECHANICAL ENGINEERING – 3rd YEAR DEGREE

FIRST SEMESTER EXAMINATIONS – 2022

ME 311– MECHANICS OF MACHINES

MONDAY, 8TH JUNE 2022 – 12.50 PM

TIME ALLOWED: 2 HOURS

INSTRUCTIONS FOR CANDIDATES

1. You have 10 minutes to read the paper. You **must not** begin writing during this time.

2. Answer **any four (4)** questions and you can do them in any order.
3. **Use only ink.** Do not use pencil for writing except for drawings and sketches.

4. Start each question on a new page and show all your calculations in the answer book provided. No other written material will be accepted.

5. Write your **NAME** and **NUMBER** clearly on the front page. **Do it now.**
6. Calculators are permitted in the examination room. Notes, textbooks or smart phones are not allowed.

MARKING SCHEME:

Question Number 1	15 Marks
Question Number 2	15 Marks
Question Number 3	15 Marks
Question Number 4	15 Marks
Question Number 5	15 Marks

Question 1

a) Describe the following constrained motions

(i) Completely constrained motion *(2.5 Marks)*

(ii) Incompletely constrained motion (*2.5 Marks)*

b) A crank and slotted lever mechanism used in a shaper has a centre distance of 280 mm between the centre of oscillation of the slotted lever and the centre of rotation of the crank. The radius of the crank is 110 mm. Find the ratio of the time of cutting to the time of return stroke.

(*10 Marks)*

The extreme positions of the crank are shown in Fig. 1

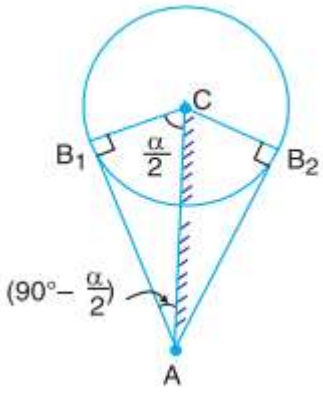

Fig. 1

Question 2

a) Name at least two important factors that determine the selection of a belt. *(5 Marks)*

b) The power is transmitted from a pulley 1 m diameter running at 220 r.p.m. to a pulley 2.5 m diameter by means of a belt. Find the speed lost by the driven pulley as a result of creep, if the stress on the tight and slack side of the belt is 1.1 MPa and 0.2 MPa respectively. The Young's modulus for the material of the belt is 90 MPa. *(10 Marks)*

The velocity ratio of creep is given by the following expression.

$$\frac{N_2}{N_1} = \frac{d_1}{d_2} \times \frac{E + \sqrt{\sigma_2}}{E + \sqrt{\sigma_1}}$$

where σ_1 and σ_2 = Stress in the belt on the tight and slack side respectively, and E = Young's modulus for the material of the belt.

Question 3

a) briefly state the differences between flywheel and a governor *(5 Marks)*

b) The mass of flywheel of an engine is 5 tonnes and the radius of gyration is 1.5 metres. It is found from the turning moment diagram that the fluctuation of energy is 50 kN-m. If the mean speed of the engine is 110 r.p.m., find the maximum and minimum speeds. *(10 Marks)*

The fluctuation of energy is given by the following expression.

$$\Delta E = I \times \frac{2\pi N}{60}\left(\frac{2\pi N_1}{60} - \frac{2\pi N_2}{60}\right) = \frac{4\pi^2}{3600} \times I \times N\left(N_1 - N_2\right)$$

Where $I=m.k^2$

Question 4

a) Define and explain the following terms relating to governors:

(i) Stability *(2.5 Marks)*

(ii) Sensitiveness *(2.5 Marks)*

(iii) Isochronism *(2.5 Marks)*

(iv) Hunting *(2.5 Marks)*

b) Write short note on 'coefficient of insensitiveness' of governors. *(5 Marks)*

Question 5

A cam is to be designed for a knife edge follower with the following data: 1. Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion. 2. Dwell for the next 30°. 3. During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion. 4. Dwell during the remaining 180°. Draw the profile of the cam when (a) the line of stroke of the follower passes through the axis of the cam shaft, and (b) the line of stroke is offset 20 mm from the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. Determine the

maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 r.p.m. *(10 Marks)*

The angular velocity of the cam shaft $\omega = \frac{2\pi N}{60}$

The maximum velocity of the valve rod to raise valve, $v_O = \frac{\pi \omega S}{2\theta_O}$

The maximum velocity of the valve rod to lower the valve, $v_R = \frac{\pi \omega S}{2\theta_R}$

The maximum acceleration of the valve rod to raise the valve, $a_O = \frac{\pi^2 \omega^2 . S}{2(\theta_0)^2}$

maximum acceleration of the valve rod to lower the valve, $a_R = \frac{\pi^2 \omega^2 . S}{2(\theta_R)^2}$

Note:

You are to only construct the displacement diagram and compute (a) and (b)