The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX4204 - Machine Dynamics**
Academic Year	:	2020/21
Date	:	11th February 2022
Time	:	09:30 to 12:30
Duration	:	3 hours

General instructions

1. Read instructions given below carefully before answering the questions.
2. This question paper consists of eight (07) questions. Answer any five (05) questions.
3. All questions carry equal marks.

QUESTION 01:

(a) **Fig. Q1(a)** shows a link OA rotating about O with a uniform angular velocity $\omega = 20$ rad/s and a block B sliding along OA with a uniform velocity $v = 2$ m/s. Determine the magnitude and direction of the absolute acceleration of B.

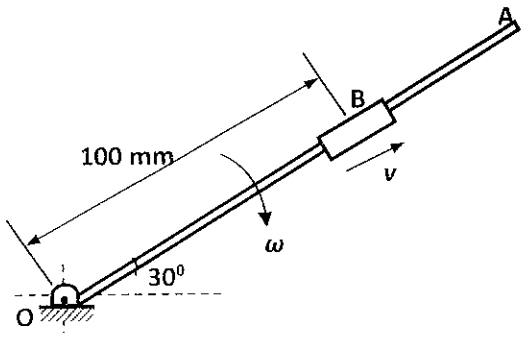


Fig. Q1(a)

(06 marks)

(b) **Fig. Q1(b)** shows the schematic view of one of the cylinders of a rotary engine. The crank OA is vertical, and it is fixed. The lengths of the crank OA and the connecting rod AB are 60 mm and 150 mm respectively. The cylinder is rotating at a uniform speed of 30 rad/s, in a clockwise direction, about the fixed centre O. For the position shown where the line of stroke is inclined at 60^0 to the vertical.

Determine;

(i) acceleration of the piston **(10 marks)**

(ii) angular acceleration of the connecting rod. **(04 marks)**

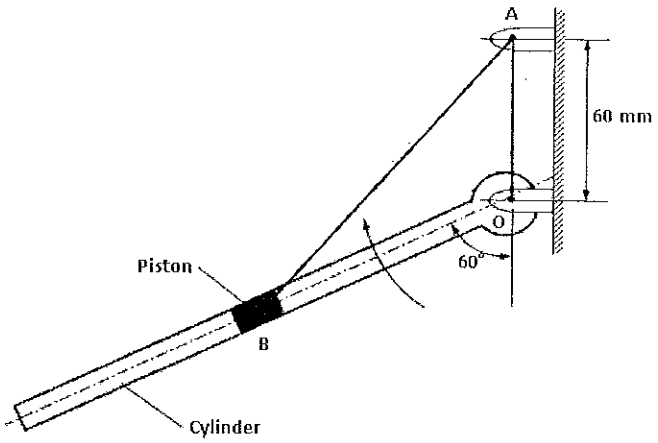


Fig. Q1(b)

QUESTION 02:

(a) Distinguish between the functions of the governor and the flywheel of an engine. **(04 marks)**

(b) An engine develops an output torque of (1600 + 360 sin 3θ) Nm, where θ is the crank angle measured from some datum. If the engine runs at a mean speed of 240 rev/min against a constant resisting torque, determine;

(i) the power developed by the engine **(04 marks)**

(ii) the moment of inertia of a flywheel which will limit the fluctuation of speed to ±1.2% of the mean speed **(08 marks)**

(iii) the angular acceleration of the flywheel when θ = 45°. **(14 marks)**

QUESTION 03:

(a) Explain the terms 'static balance' and 'dynamic balance'. **(04 marks)**

(b) A rotating shaft carries four masses, A, B, C and D rigidly attached to it; the centers of masses are at 30 mm, 36 mm, 39 mm and 33 mm respectively from the axis of rotation. The masses of A, C and D are 7.5 kg, 5 kg and 4kg respectively. The axial distance between A and B is 400 mm and that between B and C is 500 mm. The eccentricities of A and C are at 90^0 to one another.

Determine, for the complete balance

(i) the axial distance between the planes of revolution of C and D.
(ii) the mass of B.

(16 marks)

QUESTION 04:

(a) Derive the relationship of $\frac{T_1 - m\,v^2}{T_2 - m\,v^2} = e^{\mu\theta}$ for a flat belt drive with usual notations.

(06 marks)

(b) An open – belt drive is required to transmit 10kW of power from a motor running at 600 rpm. Diameter of the driving pulley is 250 mm. The speed of the driven pulley is 220 rpm. The belt is 12 mm thick and has a mass density of 0.001 g/mm^2. Safe stress of the belt is not to exceed 2.5 N/mm^2. The two shafts are 1.25 m apart. The coefficient of the friction is 0.25.

Determine the width of the belt.

(14 marks)

QUESTION 05:

(a) Explain the terms, sensitiveness, hunting and stability relating to governors.

(06 marks)

(b) **Fig.Q5** shows a Porter governor for which the speed range can be varied by means of the auxiliary spring S. The spring force is transmitted to the sleeve by the arm AB, which is pivoted at A. The two balls each of mass 0.36 kg are supported by four links, C_1, C_2, C_3 and C_4, each 75 mm in length. The sleeve carries a mass of 0.9kg.

The sleeve begins to rise when the ball revolves at 200 rev/min in a circle of 75 mm radius. The speed of the governor is not to exceed 220 rev/min when the sleeve has risen 10 mm from its original position.

Determine:

(i) the necessary stiffness of the spring S.
(ii) the tension in the link C_1 when the sleeve begins to rise.

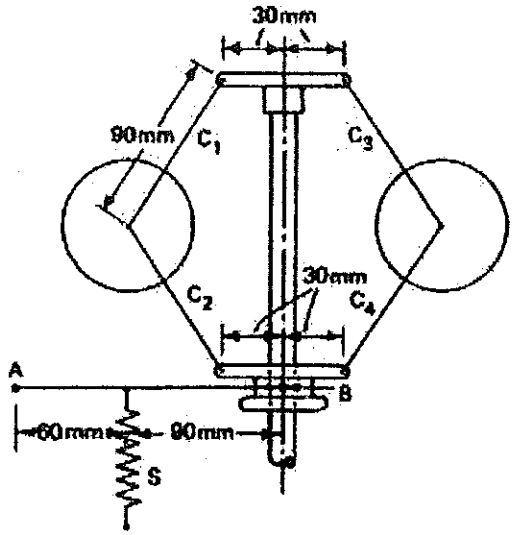


Fig.Q5 **(14 marks)**

QUESTION 06:

(a) Prove the expression for the path of contact in terms of addendum circle radii (R), pitch circle radii (r) and pressure angle (Ø) with reference to a pair of spur gears in mesh is

$$\left(R_1^2 - r_1^2\cos^2\phi\right)^{1/2} + \left(R_2^2 - r_2^2\cos^2\phi\right)^{1/2} - (r_1 + r_2)\sin\phi$$ **(10 marks)**

(b) Two gears having 30 and 40 involute teeth are in mesh as shown in **Fig.Q6**. Pressure angle $\phi = 20^0$; module m = 12 mm. The line of contact on each side of the pitch point is half the maximum possible length (path of contact). Find the height of addendum for each gear wheel and the length of the arc of contact.

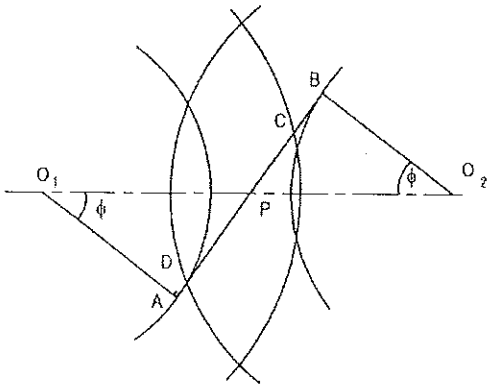


Fig.Q6 **(10 marks)**

QUESTION 07:

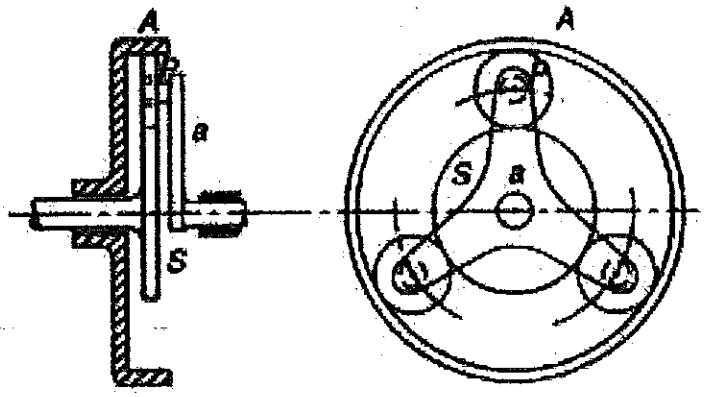
(a) Explain the difference between a simple gear train and a compound gear train.

(04 marks)

(b) Discuss the advantages and disadvantages of an epicyclic gear train.

(04 marks)

(c) The annulus A in the gear shown in **Fig. Q7** rotates at 300 rpm about the axis of the fixed wheel S which has 80 teeth. The three-armed spider is drive at 180 rpm. Determine the number of teeth required on the planetary gear wheel P.



(a) (b)

Fig.Q7

(12 marks)

END