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The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX4576 Mechanics of Machines** ME X4276
Academic Year	:	2017/18
Date	:	17th February 2019
Time	:	0930hrs – 1230hrs
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 08 (eight) questions.
3. Answer any 05 (five) questions. All questions carry equal marks.

Question No.01:

In the mechanism shown in Fig. Q1, the crank OA rotates about the fixed point O with an angular velocity ω and an angular acceleration α. The link AB connects by pin joints to OA at A and to a reciprocating piston at B which is constrained to move along XX. The lengths of the links are OA = 80 mm, AB = 160 mm. ω = 10 rad/s (clockwise) and α = 25 rad/s^2 (clockwise).

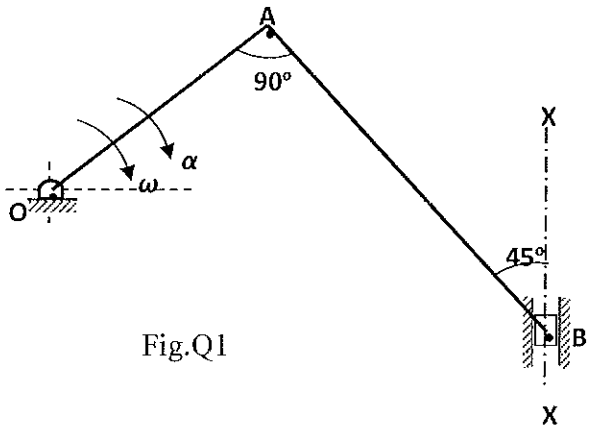

Fig.Q1

For the configuration shown in the figure, determine;

a) velocity of the piston

b) angular velocity of link AB

c) acceleration of the piston

Question No.02:

a) Distinguish the functions of the governor from the flywheel of an engine.

b) In a spring-loaded Hartnell governor, the lengths of the horizontal and the vertical arms of the bell crank lever are 50 mm and 100 mm respectively. The mass of each ball is 1.4 kg while, that of the sleeve is 6 kg. The extreme radii of rotations are 80 mm and 120 mm. The minimum equilibrium speed is 450 rev/min and the maximum equilibrium speed is 4% higher than this value. Neglecting the obliquity of the arms, determine;

i) stiffness of the spring

ii) initial compression of the spring

iii) equilibrium speed corresponding to radius of rotation of 100 mm

Question No.03:

Three masses P, Q and R are attached to a rotating shaft and their mass centres are 250 mm, 400 mm and 150 mm respectively from the axis of rotation. The masses P, Q and R are 16 kg, 12.5 kg and 20 kg respectively. The angular positions of Q and R are 60° and 135° respectively from P measured in the same direction. The axial distance between the plane of rotation of P and Q is 1.5 m, while that between Q and R is 2.0 m. Two balancing masses, each with a mass centre of 200 mm from the axis of rotation, are to be fitted in planes midway between P and Q, and Q and R.

Determine the following:

i Magnitude of each balancing mass.

ii Angular position of each balancing mass with respect to P

Question No.04:

a) State and prove the belt friction formula for a flat belt with negligible mass.

b) An open belt 4 mm thick and 75 mm wide is used to transmit power between two parallel shafts, the axes of which are 2.5 m apart. The diameter of the pulley on the driving shaft is 900 mm and it rotates at a speed of 240 rev/min. The speed ratio between the driving and driven shafts is 1.5. The belt material has a linear density of 2.5 kg/m and a permissible stress of 4 N/mm^2. The coefficient of friction between the belt and the pulley is 0.2.

Determine,

i) angle of lap of the smaller pulley

ii) maximum power that can be transmitted through the belt drive if the initial tension has been adjusted to 1100 N.

Question No.05:

A pendulum body of mass m is fixed to one arm of a bell crank lever as shown in Fig.Q5. The motion of the pendulum body is controlled by a spring of stiffness k and a dashpot of damping constant b attached to the other arm of the lever. The moment of inertia of the bell crank lever about its centre of gravity, which is at the fulcrum is I. In the equilibrium position the arm with the pendulum body is vertical. This system executes vibrations in the vertical plane. Derive the equation of motion.

Taking $I = ma^2$, obtain expressions for the damped natural frequency and the logarithmic decrement of the motion assuming the system to be underdamped.

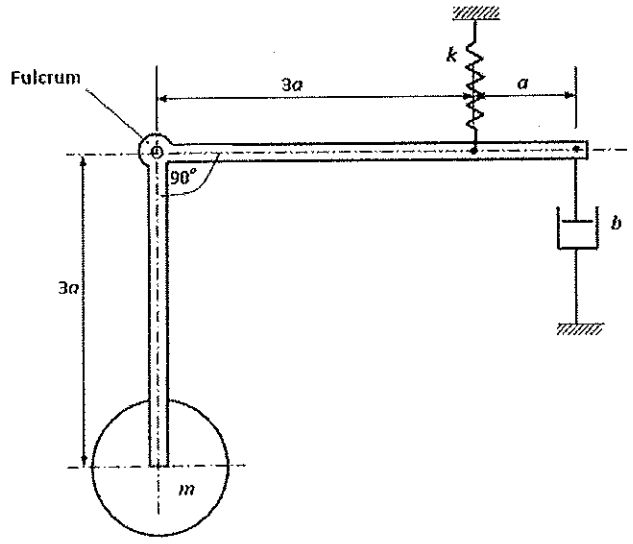

Fig.Q5

If $a = 30$ mm, $m = 12$ kg, $k = 8$ kN/m, $b = 60$ Ns/m and $g = 10$ m/s^2, determine,

i) the frequency of damped vibration

ii) the ratio of successive amplitudes on the same side of the equilibrium position

Question No.06:

a) Show that the coefficient of fluctuation of speed (k_s) of a system consisting of an engine directly coupled to a load is given by

$$k_s = \frac{\Delta E}{I\omega_m^2}$$ where,

ΔE - maximum fluctuation of energy per cycle

I - moment of inertia of rotating parts of the engine

ω_m - mean speed of the engine

b) The resultant turning moment curve of one revolution of a multi cylinder engine shows the following intercepted areas above and below the mean line of resisting torque.

-0.05, + 0.63, -0.42, + 0.51, - 0.49, +0.36, -0.58, +0.42 and – 0.38 cm^2.

Vertical and horizontal scales are 1 cm = 21 Nm, 1 cm = 60^0 respectively.

The mean speed of the engine is 24 rad/s and the fluctuation of speed is 2% of the mean speed. Determine a suitable value for the moment of inertia of the flywheel.

Question No.07:

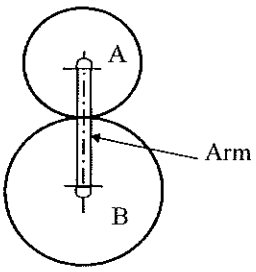

Fig.Q7

In an epicyclic gear train shown in Fig.7, the arm carries two gears A and B having 24 and 32 teeth respectively. If the arm rotates at 100 rpm, in the anticlockwise direction about the center of the gear A, which is fixed,

i) determine the speed of gear B.

ii) what will be the speed of gear B if the gear A, instead of being fixed, makes 150 rpm in the clockwise direction?

Question No.08:

a) Obtain an expression for the path of contact in terms of addendum circle radii, pitch circle radii and pressure angle (φ) with reference to a pair of spur gears in mesh.

b) Two gears having 50 and 60 involute teeth are in mesh. Their pressure angle (Φ) and module (m) are 20^0 and 10 mm respectively. The line of contact on each side of the pitch point is half the maximum possible length. Find the height of addendum for each gear wheel and the length of the arc of contact.

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