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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	:	**MEX4276 Mechanics of Machines**
Academic Year	:	2016/17
Date	:	19th November 2017
Time	:	0930hrs – 1230hrs
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions.
3. Answer any 5 questions. All questions carry equal marks.

Q1.

A friction clutch is used to rotate a machine from a shaft rotating at a uniform speed of 250 rpm. The disc type clutch has both of its sides effective, the coefficient of friction being 0.3. The outer and the inner diameters of the friction plate are 200 mm and 120 mm respectively. Assume uniform wear of the clutch, and the intensity of pressure is not to be more than 100 kN/m^2.

(i) If the moment of inertia of the rotating parts of the machine is 6.5 $kg.m^2$, determine the time to attain the full speed by the machine and the energy lost in slipping of the clutch.

(ii) What will be the intensity of pressure, if the condition of uniform pressure of the clutch is considered?

(iii) Determine the ratio of power transmitted with uniform wear to that with uniform pressure.

(20 marks)

Q2.

a) Analyse the motion of rotating body and obtain a relationship for linear velocity of it in terms of relevant variables.

(04 marks)

b) Fig. Q2 shows a quick return mechanism in which the crank OA rotates clockwise at a uniform angular velocity of 10 rad/s about the fixed point O. The crank makes the slotted lever BC to rotate about the fixed point Q. End C is connected to a slider D by a connecting rod CD. The slider D reciprocates in fixed guides. The lengths of the links are, OA = 200 mm, CQ = 150 mm and CD = 500 mm.
For the position shown in the figure draw the velocity and acceleration diagrammes and determine:

(i) Velocity of D **(08 marks)**
(ii) Angular acceleration of slotted lever BC **(08 marks)**

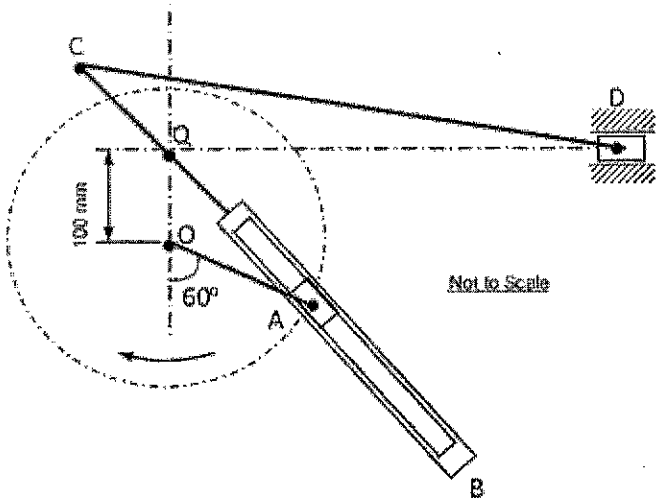


Fig. Q2

Q3.

a) State and prove from first principles the belt friction formula for a flat belt with negligible mass. **(05 marks)**

b) A belt is stretched over two identical pulleys of diameter D m. The initial tension in the belt throughout is 2.4 kN when the pulleys are rest. When this belt-pulley system is used to transmit power, it is found that increase in tension on one side is equal to decrease in tension on the other side. Find the maximum torque that can be transmitted by the belt drive. Take coefficient of friction between belt and pulley as 0.3.

(15 marks)

Q4.

a) Explain the terms sensitiveness, isochronism and stability in relation to governors.

(06 marks)

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 1.5 kg, while that of the sleeve is 5 kg. The extreme radii of rotations are 80 mm and 120 mm. The minimum equilibrium speed is 400 rev/min and the maximum equilibrium speed is 5% higher than this value. Neglecting the obliquity of the arms, determine;

(i) the stiffness of the spring **(06 marks)**

(ii) the initial compression of the spring **(04 marks)**

(iii) the equilibrium speed corresponding to radius of rotation of 100 mm.

(04 marks)

Q5.

a) If ***I*** is the moment of inertia and $\bar{\omega}$ is the mean speed of the flywheel, prove that the maximum fluctuation of energy can be expressed as

$$E_{\max} = \frac{K_s I \varpi^2}{100}$$

Where K_s is the coefficient of fluctuation of speed expressed as a percentage.

(06 marks)

b) The turning moment diagram for one revolution of a multi cylinder engine shows the following intercepted areas in mm^2 above and below the load torque line:

-47, +58, -35, +58, -55, +50, -57, +64, -36

The vertical and horizontal scales are 1 mm represent 1000 Nm and 5^0 respectively. If the mean speed is 500 rev/min and the overall fluctuation of speed is not to exceed 1.5%, determine the moment of inertia of the flywheel.

(14 marks)

Q6.

a) Explain briefly the differences between simple, compound and epicyclic gear trains.

(04 marks)

b) Of the epicyclic gear shown in Fig.Q6, the p.c.d. of the internally toothed ring Q is to be 250 mm and the teeth are to have a module of 4. The ring is stationary but the arm C carrying the planet wheel A is to make one revolution for every 5 revolutions of the driving spindle carrying the wheel B and in the same direction. Find suitable numbers of teeth for all the wheels.

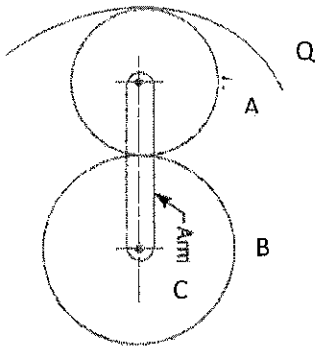


Fig.Q6

(16 marks)

Q7.

a) Explain the requirement for complete balance of a rotational mass system.

(04 marks)

b) A shaft supported in bearings 1.6 m apart projects 400 mm beyond bearings at each end. It carries three pulleys one at each end and one at the centre of its length. The masses of the end pulleys are 40 kg and 22 kg and their centres of mass are at 12 mm and 18 mm respectively from the shaft axis. The mass of the centre pulley is 38 kg and its centre of mass is 15 mm from the shaft axis. The pulleys are arranged in a manner that they give static balance. Determine

(i) the relative angular positions of the pulleys
(ii) the dynamic forces developed on the bearings when the shaft rotates at 210 rpm.

(16 marks)

Q8.

a)

(i) State the difference between the terms, overdamping and underdamping.

(ii) What is meant by natural frequency of a system?

(i) Define degree of freedom of a vibrating system.

(06 marks)

A simple pendulum of mass 0.25 kg and length 0.40 m was made to oscillate by giving it a slight push, such that the initial angular velocity was 0.05 rad/s in the sense of increasing displacement at an angular position of

b)

Determine,

(i) the angular frequency.

(ii) amplitude of motion.

(iii) the time taken by the particle to pass the initial point again.

(14 marks)

END